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ERRATA.

Page 114, line 2 from top, for *Marbury*, read *Marburg*.

P. 126, line 29, &c., *Southern edge of bow is*, should connect directly with *at Regulus* and *at pi Leonis*.

P. 153, line 20 from bottom, for *porphyry*, read *basalt*.

P. 178, line 11 from bottom, for "subjects," *read* objects.—P. 183, l. 18 from bottom, erase "of;" l. 17 from bottom, for "and," *read* a.—P. 184, *insert* the word *it*, at the beginning of the 9th line from the top.—P. 187, l. 6 from top, for "exist," *read* be.

ERRATA FOR VOLUME VI.

Page 425, and 462 index, the name of Prof. WEBSTER of Cambridge, should be J. W. instead of J. H. WEBSTER.

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[SECOND SERIES.]

Art. I.—*Review of Chambers's Ancient Sea Margins,* with Observations on the study of Terraces;* by James D. Dana.

The author of the work on "Ancient Sea Margins," has entered upon a subject of great scientific interest. It rises beyond the study of isolated deposits or local phenomena, and embraces facts bearing upon the geological history of whole continents, indicating wide changes in the earth's surface, and the latest of this general nature our globe has undergone. The truth, moreover, is exhibited in characters which cannot be mistaken even by the mind unaccustomed to geological evidence. It is marked in the condition of the soil and the extent and features of the fields of our valleys; and even the higher country along the smaller streams bears evidence that the same causes have there modified the main outlines of the land, and determined its variations of character. The farmer is well aware of the distinction of upper and lower plain or prairie along our streams, and knows that he often may distinguish the different flats by the peculiarities of soil they present.

It is a long time since the terraces of valleys and sea-shores were first noticed; yet hitherto only isolated cases, or particular valleys have received much attention. Mr. Chambers is the first who has collected together the various observations, and from these and other results of his own, has endeavored to arrive at a general deduction for the whole. He concludes that those of

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* Ancient Sea Margins, as Memorials of Changes in the relative level of Sea and Land; by Robert Chambers, Esq., F.R.S.E. 338 pp., 8vo. Edinburgh and London, 1848.

different countries point, in many instances, to a single cause operating simultaneously over distant regions. He observes:

"There is nevertheless enough to justify a question regarding uniformity of level, not only throughout North America, but also—bold as the idea, in the present state of knowledge and of hypothesis, may appear—between the old and the new continents. It has certainly appeared to myself, to say the least, as a promising prognostic of some important new views regarding a chapter in the past history of the globe, when, it being granted that terraces and benches of land are marks of ancient levels of the sea, I find that a tendency to a bench form or plateau, at 60, or from 60 to 70 feet above present high water, exists on the coasts of the United States and in the Gulf of St. Lawrence, as it does in Britain; that conspicuous terraces in Britain and in France at 188 and 392 feet, are repeated in America; that there, also, at about 545 feet, are several repetitions of a decided and most notable Scottish terrace—that Scott built his house of Abbotsford on an ancient sea-beach beside the Tweed, which finds an analogue in the first of the grand ridges sweeping from east to west behind Toronto; and that the sandy plateaux of Lanark and Carstairs are in metrical harmony with the terraces and ridges of the half-peopled wilds of Michigan."—p. 316.

This must be viewed as a bold inference, and should not be admitted without extended investigation. It is certainly a legitimate subject of enquiry, and one of the grandest in its range, before the geologist. If proved, it declares that the causes of variation in the water line, in the recent history of the globe, have acted at certain periods as widely as the ocean. If disproved, the facts indicate changes no less extensive, which have been produced at different epochs for different regions, and they show a still greater instability in the earth's surface, telling of oscillations in its various parts continued through ages since the tertiary epoch, until a whole continent has been terraced in all its valleys.*

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* In connection with the subject of terraces, we add a remark here on the word *drift*, as it is often used. It is frequently applied to any loose material on the surface, not originating where found, whether *stratified* or *unstratified*. This name being affixed to any accumulations, one or another *drift-theory* comes in to account for the facts,—such as the currents and icebergs of an ocean over the submerged lands, the action of waves of translation, or the movement of glaciers. The term in its very nature implies a theory of this general character. But there is much material of the kind called drift, which may be of sea-shore or beach accumulation; there is much also which may be of river origin, and much that may be lacustrine. Instead of determining by observation the actual facts in the different cases, and carefully discriminating, the mind is led away by the term *drift* at once to prejudge, to the confusion and error of observations. In its general signification, it had better therefore be rejected; such truthful terms as *earth*, *sand*, *gravel*, *clay*, *boulder accumulations*, are preferable, until it is fully determined that the material in any case is true drift, and not alluvial, lacustrine, or of beach or seashore origin. First prove it to be drift (often a difficult problem) and then so designate it, is a safe rule.

We have been led into these remarks by observing not unfrequently, that river terraces and beach deposits were ranked with the drift; and when once so-called, every succeeding step in investigation leads into deeper error.

Mr. Chambers introduces the subject with the following statements.

"The most familiar phenomenon connected with this subject is the existence of stripes, as well as broad expanses of low land, bordering on the sea; in many districts, of a very equable surface; sometimes of sandy, sometimes of clayey composition; occasionally presenting beds of shells: comprehending, in short, the great bulk of those flat tracts which have been—usually on account of the latter feature—recognized as ancient beaches; comprehending, also, the well-known *carses* of Scotland, as well as those still lower sandy tracts near the sea, called in our country *links*, and in England *downs*. The class of lands so described may be said to form an irregular fragmentary belting round the island, strikingly distinct from the higher grounds which rise inland—generally of great agricultural value, and remarkable as forming the sites of many of the principal towns of the empire, or of large portions of them. As they almost every where tell a plain tale as to their former submergence by the sea, the idea may the more naturally occur, that, were they by any accident re-immersed, a very important deduction would be made from the geographical area, and still more from the productive resources, of our island.

"As striking examples of this class of lands, I may point to the sea-side plain stretching for several miles on both sides of Chichester; to the similar plain extending along the south shore of the Bristol Channel, between Weston-super-Mare and Bridgewater; and to the broad expanse of low land in Lincolnshire and other parts of eastern England. The carses along the Forth and Tay—vast alluvial plains,—the low gravelly lands of Moray, and the alluvial grounds skirting the Clyde near Glasgow, are examples of equally signal character in the northern part of the island.

"It may, I believe, be safely said, that a sea 41 feet above the present would cover the whole of the districts referred to, excepting, perhaps, a few patches. The base of the comparatively steep ground rising from the interior line of these plains and stripes, even when they reach the highest grade of height, is usually at about that elevation above the sea, or a little lower. An immersion, therefore, to this extent would leave us with new coasts, not only much circumscribed, but considerably different from the present—for one thing, much bolder. It would also deprive us of the sites of the lower parts of London, Bristol, Liverpool, Newcastle, Glasgow, Aberdeen, and Inverness, and of the entire sites of Portsmouth, Southampton and Chichester, of Hull, Dumfries, Greenock, Leith, and Perth. The same submersion, extended to the Continent, would blot no small space from the map of Europe.

"Where we have large expanses of these low lands, the flatness is usually very striking. For instance, in an extensive plain beside the Bristol Channel, the equability is so great over large areas, that the Exeter Railway passes over it for twenty-eight miles (from Ashton Water to Claverham Court), with a gradual rise of only four feet; and even this perhaps is to be attributed to the lines taking an oblique course athwart the plain, and against its seaward declination. Such equability makes the land almost the rival of the sea in the trueness of its surface

to the centre of the earth, and forcibly suggests that water was concerned in giving it such a configuration. Such a plain is, indeed, precisely what would be presented to us as a piece of new land, if some of our shallow seas, such as the Bristol Channel, the mouth of the Humber, or the Solway Firth, were to sink forty feet below their present level. The carses in Scotland are also generally level, though not without partial inequalities, which a slight examination suffices to detect. In the configuration of the ground, thus level, with in many places the small inclination proper to a beach over which the tide rises and falls; in the cliffs which are often seen rising along the interior limit of the plain; in the constitution of the soil, composed of layers of sand or of clay, or of both, alternating often with beds of shells, we see clear evidence that these grounds were formed along the margins of an ancient sea; the highest inland part speaking of one about 44 feet above the present. Such is the announcement from these great expanses. When we look, however, to narrower examples of the great belting, such as are presented on bolder coasts, we find precise demonstrations, not only of an ancient sea-level about 44 feet above the present, but of several others intermediate between that and the present, particularly at 32, 27, 20, 11, and 8 feet—such appearing in the well-defined form of terraces or benches of land, the unavoidable result of the wearing power of the sea when it abuts against land of suitable slope and consistence. And, as already almost implied, these memorials of ancient sea-levels conform with each other in various parts of the island."—pp. 6–9.

The volume is occupied with details of facts from Scotland and other parts of Great Britain, and afterwards from Europe and foreign countries generally.

A brief abstract is here presented in a tabular form, first of terraces occurring in the vicinity of the sea, and next of those existing in the interior. We have preferred this arrangement, which differs from Chambers's own table, for reasons mentioned beyond.

1. *Terraces in the vicinity of the Sea.* (*Height in feet above high tide.*)

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Table Continued.

Musselburg,	20						110									
Kirkaldy,	25			56	64–80		100		125			186–190				
Stoney hill villa,				56												
Between East Duddington and the sea,					70–85 or 90											
Edinburgh,	20			56	70		110				165	186, 200			280	
The Tweed, Berwick,	30–32		44	56												
Frith of Clyde, Isle of Bute,	27–32				64		108									
Dumbarton,	32				64		104									
Glasgow,	11, 26				64–70 or 80											
Loch Linnhe. Loch Leven at Ballachulish,			42–44		65											
Loch Etive, Connel Ferry,			43		64–70											
Fort William,	32				70		96				165	187				
Dev'nshire, Barnstaple Bay,					60											
near Exeter,					67				126							
Brixham, near Tor Bay,												170–180				
Hope's Nose,					64											
Lancashire, Ribble,					60–70		100		120–128						300	
Liverpool,					60–70		100		120–128						300	
Seacombe and Egremont,					60–70–85											
River Dee, at Chester,					60–72											
River Severn, at Bristol,				50–56					128			187–193		277–282		
River Thames, near London,	30				64–90						145–150					
Sussex, near Brighton,					64											
" Chichester,			43						112–128							
" Chicham,									128							
Hamps're, Southampton water,					66											
Isle of Wight,					64				128							
Rouen,			43	55	69				126							
Norway, near North Cape,				50	78											
Spitzbergen,									128							

From the above table, there are evidently terraces of nearly the same height above the sea, common to distant regions. These heights are approximately 20 feet, 30–32, 44, 56, 64–70, 107–117, 126, 165, 185–190, 280 feet, and probably others.

2. *Terraces in the interior, remote from the Sea.* (*Ht. above high tide.*)

Valley of the Tay.—Junction with the Isla, (93 ft. ab. sea,) 146, 186.
Dunkeld, (145 ft. above the sea,) 165, 280–292.
Logierait, 281.
Beyond Killiecrankie, 497.
Blair Atholl, 500.
Taymouth, (Loch Tay 350 ft. above the sea,) 385.
Fife—on the Eden.—West Lomond Hill, 466, 543, 758–60, 996, 1338?
Ceres and Teasses, 203, 280–293, 325–330, 465, 545, 573, 599.
Falkland, 203, 243.

Strathspey.—Kingussie, (about 710–720 ft.) 760, 776, 792, 829, 853, 868.
Drumgellavy, opposite Kingussie, 997.
Farther up the valley around a lake, 1104, 1131, 1261.
Loch Ness, (45 ft.) 104, 377, 497, 530.
Dunnain, 121, 165, 189, 220, 279.
Dochnacraig, 205, 344, 461, 562, 626.
Erchet, above Loch Ness, 497.
Lochaber.—Loch Lochy, (82–89 ft.) 213.
Glen Spean and Glen Roy, 141, 167, 210, 325, 345, 372, 391, 428, 446, 520, 534, 627, 679, 703, 734, 750, 847, 1059, 1089, 1125, 1139, 1261, 1290, 1337.
Glen Gluoy, 959–969, 1159–1169.
Loch Tulla, Argyleshire, (630 ft.) 814, 907, 948, 1025, 1104, 1132.
Borthwick and Edinburghshire, 628, 656, 687, 706, 760, 821–6, 872, 968½.
Basin of Forth.—Stirling, 106–117, 165, 211.
Markinch, Leslie and Kinross, 285, 385–389, 448, 497.
Vale of Tweed.—Kelso, (83 ft.) 108, 122, 168–178.
Melrose, (270 ft.) 346, 391–393, 445, 497.
Galashiels, 542.
Eildon Hills, above Peebles, 542, 628, 675, 708, 787, 829, 872–5, 914, 967, 1024, 1087, 1133, 1166, 1196, 1226, 1282, 1336.
Lauderdale, 800–900.
Yarrow, 630, 656, 685, 709, 779, 824, 879, 958, 1081, 1126, 1186.
Dumfriesshire, Cannobie, 144, 165, 192, 219, 277, 320, 392.
Evan Vale, 1073, 1023.
Basin of Clyde.—Lanark, 675–687.
Lamington, 820, 872, 999, 1025, 1139.
Crawford, 826, 844, 910, 937, 962, 1025, 1090, 1107, 1171, 1204, 1251, 1286.
Newton, 912, 963, 1025.
Vale of Allan, Northumberland and Weardale Durham, 760, 826, 1073.
Valley of the Seine, (upper part,) 117, 126, 186–192, 238, 281, 307, 347–350, 393, 440–443, 461–465, 531, 545, 564, 576, 599, 629½.

Mr. Chambers's work contains extended descriptions of the localities mentioned, illustrated by excellent drawings.

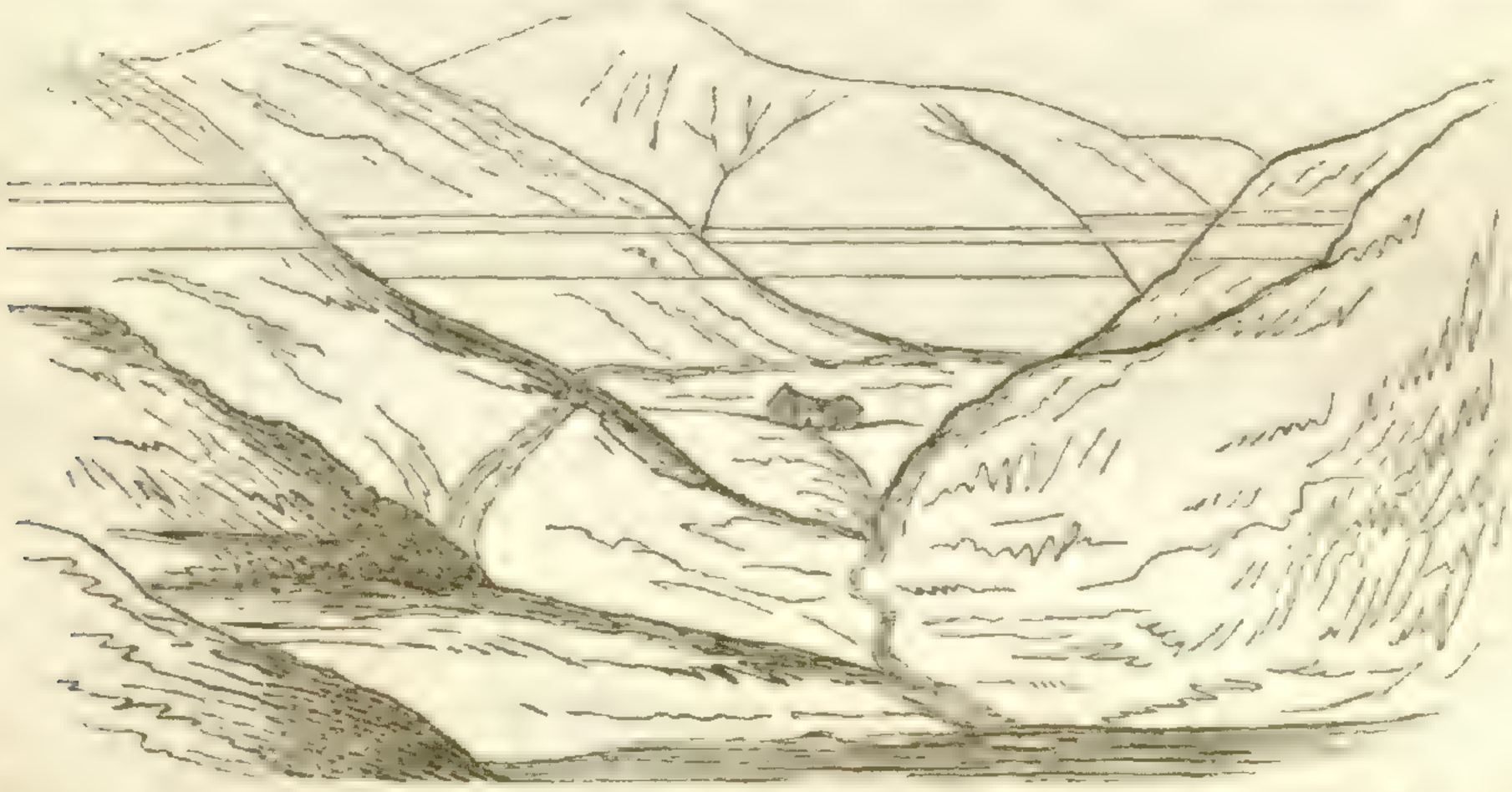
Among the most remarkable of the terraced valleys of Scotland, are those of Glen Roy and the adjoining valleys, whose terraces are called the Parallel roads or shelves of Lochaber. This region attracted the attention of Macculloch in 1817, who published an elaborate article upon them in the Geological Transactions.* Since then they have been the subject of study by Sir Thomas Lauder Dick,† Mr. C. Darwin,‡ Buckland, Agassiz,§

* Trans. Geol. Soc. London. Vol iv, 1817, p. 314.
† Trans. Royal Society of Edinburgh, 1818, volume ix, p. 1.
‡ Trans. Royal Society. London. 1839. p. 39,
§ Jameson's Edinb. New Phil Jour., 1842.

Mr. Kemp,* Mr. David Milne,† Sir George S. Mackenzie,‡ and James Thompson, Jr.§ Speaking of these Lochaber terraces, Macculloch says:—

The appearance of the parallel roads is so extraordinary as to impress the imagination of the most unphilosophical, nay even of the most incurious spectator. * * * On each side of a long, hollow, deep valley, bounded by dark and lofty mountains, and at a great elevation, three strong lines are traced parallel to each other and to the horizon, the levels of the opposite ones coinciding precisely with each other. So rarely does nature present us in her large features with artificial forms, or with the semblance of mathematical exactness, that no conviction of the contrary can divest the spectator of the feeling that he is contemplating a work of art, a work of which the gigantic dimensions and bold features appear to surpass the efforts of mortal power.

Several views of the region are given by Macculloch. The following is from Chambers, who says of the three lines, that they



extend for five or six miles on both sides of Glen Roy, and look like "copy lines ruled for text." The *first* and *second*, or two upper, were found by Macculloch to be 82 feet apart, and the *second* and *third* 212 feet. A careful survey by Mr. David Stevenson, according to Mr. Chambers, made the latter 212·37 feet, and the former 80·32 feet—a close approximation to Macculloch's determination. The height of the uppermost above high tide is 1139 feet; of the *second* 1059 feet; of the *third* 847 feet.‖

* A writer in the Athenæum, of September 23, claims for Mr. Kemp of Galashiels, his having first investigated the inland terraces of Scotland, and states that his views, which are the same as are presented by Mr. Chambers, were noticed in Chambers's Journal as early as 1840.

† Jameson's Edinb. New Phil. Jour., vol. xliii, 339, 1847.

‡ Ibid, xliv, 1. with a map, Jan., 1848. A previous memoir by Mackenzie was read on the subject before the Royal Society of Edinburgh, in 1842, and a still earlier publication appeared in Brewster's Phil. Jour. for 1833.

§ Ibid, vol. xlv, p. 49, 1848.

‖ Macculloch observes, that the first is 927 feet above the level of the junction of the Roy and Spean.

Adjoining Glen Roy lies Glen Gluoy, which opens below upon Loch Lochy. This valley has two distinct shelves or terraces, one 1159 feet above high tide, and the other 959–969 feet. Other shelves occur in Glen Spean, as well as in Glen Roy, whose heights are mentioned in the table on page 6. The whole system has afforded a fruitful, and most interesting subject of speculation. The "perfect horizontality" of the terraces, (their height above the present bottom of the valley therefore diminishing upward, instead of rising with the valley,) their extent, and the character of the region around, are the basis of the two views recently urged, the one attributing them to inland lakes, the other regarding them as beaches of an arm of the sea.

Mr. Chambers adopts the latter view : and as he discusses the character of the other terraces of Scotland and England, he arrives at the same conclusion for them all. He finds the same "ancient sea-margins" in foreign regions. In France and North America he seems to detect terraces of equivalent height with those of Scotland, and all are set down as marking *former levels of the sea*. A natural terrace and a sea-beach are therefore in his view nearly synonymous terms.

We do not pretend to deny, without examination, the conclusion in particular cases carefully studied by Mr. Chambers. But the sweeping deduction needs much, very much, restriction. And even many of his own examples demand better proof of the former presence of the sea than has been presented.

The principle that 'what has been, may again be, and the reverse,' is acknowledged to be a safe test of truth in geology. If the last elevation of sixty feet (or thirty if it be so) which Scotland has experienced, produced elevated sea-beaches, and no proper *river* terraces,—if all the existing river terraces are remains of other sea-beaches and proofs of other higher elevations,—then another elevation of sixty feet would produce a similar result, and this alone. In order to ascertain the truth, the necessary effects of such a change of level may be briefly reviewed. These effects are as follows :—

1. The formation of elevated beaches on many parts of the sea-coast about sixty feet above the sea, varying in height somewhat as actual sea-shores vary, according to their position with reference to the winds and tides.

2. The beds of rivers being raised, as well as the rest of the land, the amount of descent to the sea would be increased; and in consequence of this, their waters would run more violently, the excavating force would be augmented, and they would go on with a process of rapid degradation, until the former rate

of descent was reached. Towards the mouths of the streams the bed might be deepened the whole sixty feet. Above, the amount would vary for any given period according to the ability of the waters in different parts to wear out the material over which they pass. A hard rocky bed might prevent excavation; and if the material were yielding above such a place, the wear might there level down the surface and produce a range of slow waters, ending in rapids over the harder unyielding rocks. The amount of excavation might thus vary from sixty feet, the maximum depth, to only a few feet along the tributaries.

3. Besides depressing their beds, the rivers would act laterally, and carry off the alluvium of their banks, (when any existed,) and every flood would aid in this result, until finally, a broad flat or "bottom-land" in many places bordered the streams. Such a flat, situated within the reach of the river floods, is common on parts of all rivers where their descent is not too rapid. The breadth of the flat would depend on the amount and force of the waters during floods, and it would necessarily be bounded by a steep slope rising to an upper level. Where the valley was narrow, all the former alluvium might be carried off; where broad, some portions would be left.

4. The result would be the same whether the rise were gradual or abrupt. If the latter, the river would have more rending power towards its mouth, and the deepening would go on more rapidly. If a slow gradual rise should commence at any time, the river, through its increasing excavating power, would begin to sink between its banks, and the wear of the alluvial flat either side by floods would also commence. The terrace slope would also show its first beginnings, as an outline to the river flats. Finally, the stream would have a bank of its former height,—this height being a constant quantity for the stream;—it would have more or less broad flats, which flats or bottom-lands would commonly be bounded by a slope; and, if the former alluvium remained, there would be a shelf or terrace above.

5. From the conditions mentioned in the last paragraph, it is evident that during a gradual elevation, (and as gradual a sinking of the stream,) the outline of the lower flat might be varied, in consequence of a change in the bed or banks of the stream which should vary its direction or the direction of its principal current; and, that therefore in the course of one and the same rising, a terrace of sixty feet might form in one place, and in another, perhaps not far distant, one of twenty, and another of forty;—or one of ten, and another of thirty, and another of twenty; and so on. In still other places the upper alluvial plain

might descend by a very gradual inclination to the lower flat, instead of forming a proper terrace; or part way it might be gradually declining, and then fall off with the rapid slope that usually bounds a terrace. These are all possible results of the causes mentioned and are to be looked for in nature.

6. The lakes of the country, where they could at once empty themselves, would correspond with the rivers in the results produced, and each terrace might indicate in many cases a separate elevation. When they remained closed by a barrier, they would either gradually become emptied, or by abrupt steps at intervals; and hence there might be several terraces differing in height from any along the rivers, (indicative of the progress made at successive periods,) and differing from those of a neighboring lake.

7. The terraces of a river without lakes, in the case supposed, would have the terrace plains approximately parallel with the bed of the stream. Where there were lakes, the terraces would be horizontal, and the stream left in the valley might ultimately have (as in Glen Roy) a rapid descent. It should be remembered, that the descent of large rivers, and consequently the corresponding slope of their flats, is but *one or two feet to the mile;* and hence great accuracy in leveling may be necessary to detect a variation from horizontality.

By way of farther illustration, suppose North America to rise sixty feet, (or the sea-level to sink this amount.) The Mississippi has now a lower flat in some places exceeding twenty miles in width; on the Ohio the flat is often over five miles, on the Connecticut over a mile: and so with other rivers. The great river of the west, would soon work its bed down the sixty feet. Its banks,—since their height has a relation to the existing level of the river—would be reduced to their present elevation; and some miles back a terrace of sixty feet would mark the limits of the new formed lower flat. The same result or something analogous would take place on the Ohio and all the other rivers of the country. Even the streamlets that constitute their head waters, high up among the hills, would each form its terrace where there were proper alluvial shores; for the slope of the whole from the summit rill to the mouths of the rivers at the sea, would gradually have become increased by the elevation of the country, and the process of excavation would therefore affect every part of the land. There would not necessarily be an identity of height in the terraces formed, for the reasons stated in §§ 2 and 5.

If these are facts,—and who can doubt it—the formation of every elevated beach along a coast, must be attended by the form-

ation of numberless terraces along the rivers of the elevated country. If so,—for the sixty feet rise Scotland has experienced, there must be river terraces of cotemporaneous origin even over the higher lands of the country; every river will tell the tale as well as the beach along the coast. If so,—the terraces described by Chambers as occurring over these upper regions, cannot all be proofs that the sea there left beaches: and it remains for investigation to establish by other evidence than the mere existence of such "benches" or "shelves" of land, that any are of that origin. Indeed the whole work, as far as the subject bears upon the question of elevation, remains yet to be done, excepting the observations relating to the exterior of the island. If there have been elevations of the land corresponding to the sea-shore terraces of 20, 32, 56, 64, 117, 126, 188 feet, there must for the reasons stated, be traces of river-terraces high up on the land, corresponding to each elevation, making a most complex problem for investigation to unravel. These facts have led to our separating the sea-shore terraces from the others, in the table given on a preceding page.

8. Another consideration comes in, complicating still more the problem. Suppose the coast to be raised independently of the country back, or to a greater height. This is a possible case, and should be a matter of investigation. It is obvious that the river excavations would be confined to the parts towards their mouths, and here the terraces would be found. At certain places, the slope of the river's bed would be diminished instead of increased; and in such parts the water would be set back;—its bed would fill up;—its flats would be flooded more frequently than before, or perhaps constantly, and they would consequently increase in height by new accumulations. Near the sea, in such a case, the river terraces might slope with the bed of the stream, while in other places they would be absolutely horizontal, and higher up the valley be wanting altogether.

9. One important conclusion, obvious without farther remark, is that the terraces in the higher portions of a country are not satisfactory evidences of as many distinct elevations—nor of the actual height of any elevations the country may have experienced. The terraces toward the sea are more trustworthy.

There is a certain rule in the examination of rock deposits—well understood and generally applied—which is entirely neglected by Mr. Chambers and many others in the study of terraces. It is this:—that the marine origin of a bed is *to be proved* by its resemblance to marine formations and its containing marine relics. Consider for a moment the characters of a line of coast.

1. In many places above the water line, there are beach accumulations; and these accumulations are sandy and distinctly stratified. The layers though thin and distinct are irregular, not of very great lateral extent, but frequently blending and changing their direction. There is often a slope in the layers having the inclination of a beach.

2. There are drift heaps on many exposed coasts, formed by the winds and higher seas above the true beach accumulations. These also are stratified (or laminated when solidified), each sheet of sand blown over forming a separate layer. The layers are very irregular in dip, often curving (like the top of the drift heap), and frequently changing their direction. They are often cut off abruptly and overlaid unconformably by other layers, as a sand drift is often beheaded by a gale, again to increase by new accumulations. Such drift heaps sometimes form interrupted ridges along a coast, forty, fifty or sixty feet in height.

3. Below the water level, there are often flats or slopes of gravel, sand, or silt. The material is frequently in delicate layers, and the layers may be of wide or small extent, often (when in extended banks) scarcely varying from horizontality yet sloping where the bottom slopes. They are frequently rippled by the waves, or agitated into parallel ridges, in some cases even at a depth of five hundred feet, and flexures like those of the rippled surface will be apparent in the layers beneath. Again, when the waves on a shore break and flow over a bank in shallow waters, they roll up the sand in a series of slopes; such banks may therefore be composed of horizontal layers, while the layers themselves occasionally consist of subordinate inclined layers.

4. The sandy beaches in some places contain worn shells; but very frequently they are destitute of such remains, owing to the trituration of the sands destroying those that may be thrown up. The muddy deposits often afford more or less of animal life of various kinds, and among them shells are common, worn or unworn.

The muddy deposits containing molluscs and those beach accumulations that include worn shells, will together, constitute a certain proportion of a line of coast, and the former a larger proportion of the estuaries. The proportion for any coast should be ascertained, that it may be used as a key towards studying the accumulations over the country back.

5. There is a minimum width for long arms of the sea, which should be compared with the width of interval between opposite terraces on rivers.

Allowing now for a large part to be carried off by waters after an elevation, it is evident that there will still remain in some parts among sea-coast formations, indications of their marine origin. Such evidence is yet to be found in our upper terraces. And until it is obtained, there is no safety in the inference that the terraces,

extending as they do throughout the interior of a whole country, are marine. It will be time enough to speculate on the facts, when they are ascertained. The terraces consist of material of all kinds, from the coarsest pebbles to the finest silt, and assuredly the sea, if the source, must have left some traces of itself and its productions, which may be detected where such extensive deposits remain undisturbed.

The writer has observed terraces along the rivers of Oregon and California as well as in the eastern portion of our country, and for some years has been hoping to take up the subject for special study, feeling assured that a phenomenon which so pervades a continent, as is evident throughout the United States from east to west, must afford conclusions of the highest interest to geology. Mr. Chambers's work contains much valuable material, showing at least the wide distribution of terraces over his own country, as well as to some extent in other lands. But more study is required before the great body of the facts he has collected are made available to science. The subject should be entered upon in the manner exemplified by that accurate and laborious Scotch geologist, Macculloch,* and carried out with still more minuteness of detail.

1. The heights of the terraces above the bottom of the river valley on both sides, should be measured by careful leveling, and sections should be thus made through the whole course of a stream from its mouth to its head, at as many places as practicable.

2. The height of the river above the sea should also be obtained for each place, where a section is thus made.

3. The horizontality or slope of the terrace plains along the valley should be determined: and to this end the length of any breaks in a line of terraces, met with on the ascent of a stream, should be noted, and the physical features where such breaks occur, in order to understand the causes of them: also the nature of the river's bottom, upon which fact it often depends whether the terraces may or may not correspond in slope with the existing slope of the stream, and also what may be their height in different places.

4. The relation should be ascertained, if there be any, between the heights of terraces on the smaller tributaries and those of the main stream, or between the stream where the descent is rapid and where it is nearly horizontal; also between small and large streams in the same vicinity.

5. The character of the deposits, whether alluvial, lacustrine, or of beach or sea-coast origin, applying the tests mentioned, should be matters of thorough investigation. Assuredly, if no marine relics or indications are found along a river's terraces for one or two hundred miles, it would be defying all geological principles to assert that such deposits were marine.

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* See Geol. Trans., vol. iv, pl. 21.

A river valley should thus be surveyed from its mouth to the heads of all of its tributaries. The Connecticut in our own country affords a most interesting region for investigation; for the terraces are on a magnificent scale, and may be traced, as the writer has seen, even among the White Mountains. One river thus studied, will be a standard of comparison; and when a whole country has been carefully examined from the shores to its higher summits, we shall have certain and satisfactory data for some grand deductions. We may then hope to learn which terraces belong to one and the same epoch, and to what extent they are measures of the elevations of a country. After these points are determined, we may look for a full elucidation of the former changes of level a continent has undergone during the period included, or perhaps may prove coincidences between distant countries that will point to some principles in geological dynamics yet but half acknowledged.

The writer has said nothing upon the effects of glaciers, as they will be better learned from those who have made them their study. The course of investigation pointed out precedes the application of any theory to account for the facts.

We do not attempt a review of the known facts relating to terraces in this country, since they can establish little more than the general truth of their existence, until a systematic series of observations is carried out.

New Haven, November, 1848.

ART. II.—*On a New Formula for Interpolations;* by J. H. ALEXANDER, Esq.

I HAVE given to the following formula, the epithet of *new*, not as claiming any thing for it in that behalf; for, in so far, it is neither the better nor the worse: but simply, because it *was* new to me at the time I developed it for my own use. That it will be new to others now, by no means necessarily follows; indeed, from the readiness with which the elements submit themselves to the requisite decompositions and transformations, rather the opposite is to be presumed. The principle of the method is certainly as old as Descartes; and the form of it, even, may occur in some of the mathematical writers, not long after him but now ancient for us; although, from comparatively slight familiarity with those writers, I am not aware of its existence. At all events, however, it does not appear in some of the most recent treatises on the special subject, where one would naturally expect to find the fruits both of ingenuity and of research; and therefore having recognized, for a good while and frequently, the ease and fecun-

dity of my method, I suppose it will not be an unwelcome addition to our existing analytical apparatus. It may be so expected, especially at this period, when there is less lack of observations in the physical sciences than of elegant, or even expert, methods in their subsequent employment; and, in so far, what follows may be considered as a contribution to a fruitful and extensive part of the Art of Observing.

Interpolation is, in general, analytically the supplying of missing or required quantities within or beyond (either positively or negatively) a series whose given quantities progress according to some certain, but unknown, ratio. When the ratio is known, it is of course more convenient to find the required quantities by the equation it furnishes. Such quantities, if numerical, are (or are assumed for the purpose of interpolation to be) terms in a series of figurate numbers; and the order of the series, as well as the equation by which it is generated, is determinable by the number of removes after which the differences of the successive terms become constant, or, in most practical cases, by the actual number of terms given in the series. In geometry, a similar application of it is made for the determination, by rectangular co-ordinates, of a line subject to the condition of passing through a given number of points.

In this last aspect, if the number of points given be no more than two, it is manifest that the conditions of the question are met by a straight line. If the points are more than two, and the construction does not shew the co-ordinates for such points to be in the relation of the base and perpendicular of a right-angled triangle, the development of the line required must be by a curve traced from point to point by means of an ultimate reduction to this same relation. It is plain that such curves may be as varied as the number and positions of arbitrary points given for their determination; but the order to which they belong and the character of the curve itself, follow from the degree and co-efficients of the equation which is found to express the respective values of its abscissa and ordinate. Thus in all the curves determined by normal sections of an equilateral cone, the equation for the ordinates is of the second degree; all arcs of a circle, therefore, are lines of the second order, and so are those of an ellipse and common parabola: but the character of the former of these is still farther defined by the co-efficient expressing the ratio between its transverse and conjugate diameters, and of the latter, by the co-efficient of its parameter. The cubic parabola, however, still coupled with a similar co-efficient, presents an equation for ordinates of the third degree, and is therefore a line of the third order.

I may remark here, in passing, that writers on analytical geometry have not unanimously retained these distinctions in view;

but have sometimes treated the subject as if *curves* were essentially different from straight lines. Hence, what are really *lines* of the second order, have been termed by some, *curves* of the first degree; and so on. It hardly need be said that this is in so far a defect in the generality of the method; and that it imposes the necessity of a subordinate and at least cumbrous discrimination between *degrees* and *orders*, the first being the appellations of the equations, and the second, of the curves dependent upon them.

For the present aim, such discriminations would but tend to confuse. And the geometrical aspect which the formula affects, is that of the hypothenuse of a triangle or the arc of a curve, having a general characteristic equation of the form $y^n = ax$ (and therefore parabolic), but divisible into as many different degrees or orders as there are assignable values of n. The origin of the co-ordinates is placed at the apex of the triangle, and at the pole of the curve, in the respective cases; in the last the characteristic equation assumes the form $y = \overline{ax}^{\frac{1}{n}}$, which brings the ordinates to the linear scale and makes the base on which they are measured, tangent to the curve at the pole; while the different abscissæ, x', x'', x''', etc., are in fact portions of diameters intercepted between the arc itself and points in the base of the ordinates corresponding to the values of y', y'', y''', etc.

But geometrical illustrations are, in general, intelligible with difficulty, unless accompanied by delineations; I prefer, therefore, to place the explanation of the formula upon the theory of figurate numbers; to which, as already said, the doctrine of interpolations belongs. Of course the derivation of the formula will be equally satisfactory, whether it be made to flow from extension or from numbers; and the numerical deduction will have the advantage of being of the same kind with the cases that occur most abundantly in practice.

These *figurate* numbers, then, are the terms of various artificial series, constructed from and corresponding to the natural series of numbers in such wise that if the general term of this last be called $\frac{n}{1}$, the general term of the others will be expressed by $\frac{n}{1} \cdot \frac{n+1}{2}$; $\frac{n}{1} \cdot \frac{n+1}{2} \cdot \frac{n+2}{3}$; $\frac{n}{1} \cdot \frac{n+1}{2} \cdot \frac{n+2}{3} \cdot \frac{n+3}{4}$; and so on.

Thus for instance, substituting in the expression, $\frac{n}{1} \cdot \frac{n+1}{2}$, the successive values of n (1, 2, 3, 4, 5, etc.,) from the natural series, we have a figurate series, as under;

natural series:	1.	2.	3.	4.	5.	&c.
figurate series:	1.	3.	6.	10.	15.	&c.

If we use the next expression $\frac{n}{1} \cdot \frac{n+1}{2} \cdot \frac{n+2}{3}$., we shall develop a

figurate series: 1. 4. 10. 20. 35. &c.

And the expression following would give rise to still another

figurate series: 1. 5. 15. 35. 70. &c.

It is seen in the algebraic notation of these, that not only the individual terms of each, but the general terms of all, are in a regular progression. Thus the first or natural series, comprehends only the lowest power; the next involves the square of the given term and so presents an equation of the second degree; the third offers an equation of the third degree; and so on. This is precisely accordant with what was just now deduced in the consideration of straight lines and curves.

The powers of n, occurring in these different equations, correspond also to the degrees of removal from the original series at which the differential series becomes constant. Thus taking again

the natural series: 1. 2. 3. 4. 5. &c.
1st differential do.: 1. 1. 1. 1. &c.

That is to say, the differences are already constant at the first remove.

If we take a series of the second order, involving the second power of n, we have

second order: 1. 3. 6. 10. 15. &c.
1st differential: 2. 3. 4. 5. &c.
2d differential: 1. 1. 1. &c.

and the differences become constant at the second remove.

These instances are sufficient to show the generality of what is affirmed; that the index of the power involved in the equation, indicates also the number of removes at which the differences of the terms become constant. It is upon this, that the ordinary method of interpolation is founded; but the distinction between that method and the formula now proposed, is that while the former requires the use of the differences themselves and in cases of intermediate interpolation the tabulation of the results, the latter employs in all cases only the original terms, and uses the differences only so far as may serve in the absence of other means to determine the degree of the equation and of the figurate series in which the quantities given are to be arranged.

The order of the series and the number of terms necessary for solution are, it is manifest, correlatives; and the law which connects them is, that the index of the order $+1$ is the said number. Thus, in a series of the first order, the given quantities in which, progress lineally or by one constant difference, only two terms are necessary for interpolation of the remaining terms;

just as, geometrically, two fixed points are enough for determining the position and direction of a straight line. In a series of the third order, it is necessary to use four terms; and in one of the fourth order, five terms, for its development.

The choice, however, in any case, of the proper number of terms to be involved in the calculation, is not arbitrary; but depends in each instance upon the character of the series in question. Where such a series corresponds with equidistant ordinates, in general successive differences of its terms may be taken; and the degree of removal where such differences are constant, is the degree of the equation applicable and the order to which the series itself belongs. Thus if we have corresponding to

the ordinates:	1″.	2″.	3″.	4″.	5″.	&c.,
a series:	16 ft.	64 ft.	144 ft.	256 ft.	400 ft.	&c.,

(whose terms, in fact, represent the spaces passed over by falling bodies in the respective times) we shall have also

1st differences	48.	80.	112.	144.	&c.
2d "		32.	32.	32.	constant.

The equation of this series is of the second degree, then; and any three terms of it, are sufficient for the interpolation of the rest.

So, if we take the series of expansions of iron, (whose length is 1.— at 0° Centigrade,) corresponding to the temperatures indicated respectively by the

ordinates:	100° C.	600° C.	1100° C.	1600° C.	2100° C. &c.
expansion series:	0·00114	0·01148	0·03006	0·05751	0·09446 &c.

we shall have,

1st differences:	1034.	1858.	2745.	3695.	&c.
2d "		824.	887.	950.	&c.
3d "			63.	63.	constant.

Its equation, then, is cubic; and four terms are necessary to interpolation of other terms of such a series.

The same conclusion may be arrived at by other considerations, sufficiently probable to serve as guides. As the ordinates actually expressed in degrees Centigrade are equidistant, they may be transformed into the natural series, having its first term at 100° C., thus 1, 2, 3, 4, &c.; and we can then judge what power of this natural series will correspond the nearest with the actual expressions. The presentment may be conveniently made in the following form:

Actual ordinates:	100°	600°	1100°	1600°	2100°:
Transformed terms:	1	2	3	4	5 :
Squares:	1	4	9	16	25 :
Cubes:	1	8	27	64	125 :
Fourth power:	1	16	81	256	626 :
Actual experiments divided by 1st term:	1	10·07	26·37	54·48	&c. :

It is evident upon this, that an equation of the second degree would be much below the divergence of the series; and that one of the fourth is still more above it. We are, therefore, warranted in regarding it as cubic, and in interpolating accordingly.

This method applies more emphatically to cases where the ordinates are not equidistant. For instance, taking a series from experiment on the resistance of still water; in which the ordinates represent miles per hour in the speed of the vessel, and the abscissæ are the resistances measured in pounds respectively; we have

	mile.	miles.	miles.	miles.
ordinates:	1·925	2·222	2·628	4·045
	lb.	lb.	lb.	lb.
resistance-series:	11	13·08	18·10	47·26

Transforming these, in dividing each by its first term, we produce

ordinates:	1	1·154	1·365	2·101
squares:	1	1·33	1·86	4·41
cubes:	1	1·54	2·54	9·49
resistances:	1	1·19	1·64	4·30

It is very plain from this, that the resistances increase more rapidly than the simple ordinates, but do not transcend the ratio of the squares. The series of cubes has been given only for abundant illustration. We are limited, then, in this instance to an equation of the second degree.

These methods will cover the most of cases occurring in practice; nearly all which already, in point of fact, do not transcend a series of the second order. Cases may occur, however, in which for various reasons they could not be applied safely; and where it is desirable to use all the terms given by observation. To such as these, the formulæ I propose are, I believe, peculiarly applicable. These formulæ I shall now at length present.

Calling a, b, c, d, ... &c., the first, second, third, fourth, &c., (equidistant) terms in a series; and l, any term whose place in the series, or rather the number of whose place, is n; we have generally

I. When *first* differences in the given series are constant,

$$l = \overline{n-1} \,.\, b - \overline{n-2} \,.\, a;$$

II. When *second* differences are constant,

$$l = \frac{\overline{n-1} \,.\, \overline{n-2}}{1 \,.\, 2} \,.\, c - \overline{n-1} \,.\, \overline{n-3} \,.\, b + \frac{\overline{n-2} \,.\, \overline{n-3}}{1 \,.\, 2} \,.\, a;$$

III. When *third* differences are constant,

$$l = \frac{\overline{n-1} \,.\, \overline{n-2} \,.\, \overline{n-3}}{1 \,.\, 2 \,.\, 3} \,.\, d - \frac{\overline{n-1} \,.\, \overline{n-2} \,.\, \overline{n-4}}{1 \,.\, 2 \,.\, 1} \,.\, c + \frac{\overline{n-1} \,.\, \overline{n-3} \,.\, \overline{n-4}}{1 \,.\, 2 \,.\, 1} \,.\, b - \frac{\overline{n-2} \,.\, \overline{n-3} \,.\, \overline{n-4}}{1 \,.\, 2 \,.\, 3} \,.\, a;$$

IV. When *fourth* differences are constant,

$$l=\frac{\overline{n-1}.\overline{n-2}.\overline{n-3}.\overline{n-4}}{1\ .\ 2\ .\ 3\ .\ 4}.e-\frac{\overline{n-1}.\overline{n-2}.\overline{n-3}.\overline{n-5}}{1\ .\ 2\ .\ 3\ .\ 1}.d+\frac{\overline{n-1}.\overline{n-2}.\overline{n-4}.\overline{n-5}}{1\ .\ 2\ .\ 2\ .\ 1}.c-$$
$$-\frac{\overline{n-1}.\overline{n-3}.\overline{n-4}.\overline{n-5}}{1\ .\ 2\ .\ 3\ .\ 1}.b+\frac{\overline{n-2}.\overline{n-3}.\overline{n-4}.\overline{n-5}}{1\ .\ 2\ .\ 3\ .\ 4}.a.$$

Such are the formulæ covering a case where as high as *five* terms of the original series, concur for the interpolation. It would be easy to extend them further; but the occasion for it will hardly occur in practice. I have left them in their present shape, in order to show more clearly the mode of their generation and their symmetry; besides, this shape will also be found as convenient for calculation. A transformation, however, can very easily be made; that may be preferable for those who make the entire calculation, for greater security, upon paper. The second series, for instance, will then assume the form;

$$\text{II. } l=\frac{n^2-3n+2}{2}.c-(n^2-4n+3).b+\frac{n^2-5n+6}{2}.a.$$

It is hardly necessary to cumber this paper with farther merely elementary processes.

It may be remarked that the form of these several series is apparently *divergent;* they are not less applicable, however, to series that *converge*. The change of signs follows such characteristics, and unerringly regulates the result.

I shall now offer in proof, some illustrations of the application of the formulæ to practical cases; in which there will be an opportunity of comparison with the methods of interpolation ordinarily employed.

1. Weisbach, in his learned essay on Observations,* has given the following series of temperatures and pressures, furnished by certain experiments on steam; viz.

Pressures in atmospheres:	1	1·5	2	2·5
Temperatures (Centigrade):	100°	112°·2	122°	129°;

and desires then to interpolate the temperatures proper to pressures of 1·1; 1·2; 1·3: 1·4 atmospheres, respectively. He assumes, also, that the differences in the temperature-series, are constant in the second place; and, therefore, employs in fact but the first three terms. As my object is only to compare my proposed method with the habitual one under the same assumptions, I shall not stop now to discuss the propriety of these; but shall give at once the numerical substitutions in my formula.

In arranging the equidistant pressures: 1. 1·5. 2. 2·5; &c.
according to the natural series for ordinates, viz.: } 1. 2. 3. 4. ; &c.

*Allgemeine Maschinen Encyclopädie; von Hülsse u. A. Art. Beobachtung.

the epochs for interpolation required between the first and second terms, become (instead of 1·1; 1·2; 1·3; 1·4;) 1·2; 1·4; 1·6; and 1·8, respectively. These are the values then to be successively substituted for n in the formula II, in order to obtain the values of l in terms of the temperature. Taking, then, a, as 100°; b, as 112°·2; and c, as 122°; and calling $n = 1{\cdot}2$, we have

$$l = \frac{1{\cdot}44 - 3{\cdot}6 + 2}{2} \cdot 122 - (1{\cdot}44 - 4{\cdot}8 + 3) \cdot 112{\cdot}2 + \frac{1{\cdot}44 - 6 + 6}{2} \cdot 100$$

$$= 102°{\cdot}632.$$

When n is 1·4, then

$$l = \frac{1{\cdot}96 - 4{\cdot}2 + 2}{2} \cdot 122 - (1{\cdot}96 - 5{\cdot}6 + 3) \cdot 112{\cdot}2 + \frac{1{\cdot}96 - 7 + 6}{2} \cdot 100$$

$$= 105°{\cdot}168.$$

When n is 1·6, then

$$l = \frac{2{\cdot}56 - 4{\cdot}8 + 2}{2} \cdot 122 - (2{\cdot}56 - 6{\cdot}4 + 3) \cdot 112{\cdot}2 + \frac{2{\cdot}56 - 8 + 6}{2} \cdot 100$$

$$= 107°{\cdot}608.$$

And finally when n is 1·8, then

$$l = \frac{3{\cdot}24 - 5{\cdot}4 + 2}{2} \cdot 122 - (3{\cdot}24 - 7{\cdot}2 + 3) \cdot 112{\cdot}2 + \frac{3{\cdot}24 - 9 + 6}{2} \cdot 100$$

$$= 109°{\cdot}952.$$

Assembling these results into a series, and letting the epochs of pressure return to their actual value, we have, as under—

Pressures in atmospheres:	1.	1·1.	1·2.	1·3.	1·4.	1·5.	2. &c.
Corresponding temperatures:	100°;	102°·632;	105°·168;	107°·608;	109°·952;	112°·2;	122°. &c.

It is hardly necessary to say that these interpolated results are exactly the same with those that Weisbach arrives at, after a more complicated process.

2. Wallace, in his article on Interpolation, for the Edinburgh Encyclopedia, has quoted the following lunar distances of Aldebaran, viz.

1847. Nov. 1.	Noon,	53°·20′·16″;	Midnight,	59°·33′·47″;
Nov. 2.	"	65°·52′·58″;	"	72°·18′·10″;

and has then calculated the corresponding distances at the third, sixth and ninth hours, respectively, of the first interval. I shall compare his results with those of the present formula.

Ranking the given terms in a natural series of equidistant intervals of 12 hours, and reducing the angular values to seconds of space for convenience, we have as follows:

Ordinates,	1.	2.	3.	4.
Distances,	192016″.	21427″.	237178″.	260290″.

The epochs of the ordinates for interpolation are then 1·25; 1·50; 1·75, respectively. I need only give, for illustration, the substitution of one of these epochs in the formula III; which as there are four terms is the one properly applicable. Taking, then, the value of n at 1·5, and substituting for a, b, c, d, the numerical distances in their order, we have

$$l=\frac{0\cdot5\,.\,-0\cdot5\,.\,-1\cdot5}{1\,.\,2\,.\,3\,.}\,.\,260290-\frac{0\cdot5\,.\,-0\cdot5\,.\,-2\cdot5}{1\,.\,2\,.\,1\,.}\,.\,237178$$
$$+\frac{0\cdot5\,.\,-1\cdot5\,.\,-2\cdot5}{1\,.\,2\,.\,1\,.}\,.\,214427-\frac{-0\cdot5\,.\,-1\cdot5\,.\,-2\cdot5}{1\,.\,2\,.\,3\,.}\,.\,192016;$$
$$=0\cdot0625\,.\,260290-0\cdot3125\,.\,237178+0\cdot9375\,.\,214427$$
$$+0\cdot3125\,.\,192016;$$
$$=16268''\cdot125-74118''\cdot125+201025\cdot3125+60005;$$
$$=203180\cdot3125=56^\circ\,26'\,20''\cdot31$$

A similar substitution for the other epochs will enable us to transform the series, as under:

Nov. 1st—Noon.		3 P. M.	6 P. M.	9 P. M.	Midnight.
Distances,	53°20′16″	54°53′7″·96	56°26′20″·31	57°59′53″·20	59°33′47
do. Wallace,	"	54°53′8″	56°26′20″	57°59′53″	"

It is thus seen that the formula, with but little (if any) more figure-work, is not deficient either in accuracy or in precision. The arithmetical operations might even have been abbreviated, by dividing at once all the terms in the series of distances by the first term. The answers would have been produced by multiplying at least each result by the same constant factor. But artifices of this kind belong, of course, to the working of any formula.

Such a division, however, might have been useful for another purpose, as I have already mentioned; namely, to determine the order of the equation to be employed. As in the present instance, the object was only a comparison of methods, and as all four terms had concurred in the method of Wallace, they were of course used equally and without question in my own. It is however easy to see that many practical cases may occur, in which more terms are given than would be necessary, or even proper, to employ under the physical relation of the question. In the example just now from Weisbach, there were four terms given too, but only three were employed. In the last example, the terms were no more than necessary, as will be seen by the following transformations and parallelisms.

Epochs in time.	1.	2.	3.	4.	&c.
Distances divided by 1st term.	1.	1·116	1·235	1·356	&c.
$\sqrt{}$ epochs:	1.	1·414	1·732	2·——	&c.
$\sqrt[3]{}$ epochs:	1.	1·260	1·442	1·587	&c.
$\sqrt[4]{}$ epochs:	1.	1·184	1·316	1·414	&c.

It is manifest upon inspection, (and still more by executing numerically the ratios,) that a cubic equation developes a series the most nearly approaching that of the distances themselves.

These two examples, drawn from astronomy and general physics, are sufficient to illustrate the method of interpolations by the present formula, when the terms of the given series are equidistant. I shall now present some cases, which have furnished examples already to others; and in which, the ordinates are not equidistant. In point of fact, in a great many physical observations, it is extremely difficult to preserve such isotomy; and there is hardly ever a case of experiment or observation, though admitting in one of its series a progression by regular multiples, in which all the successive terms can be accepted by the observer, as of equal reliability. The application of the formula to broken series of this kind, is, therefore, of the highest interest.

3. An instance may be taken, already cited by Wallace, where the distances of a comet from the sun's centre, were as follows, at the given epochs, viz.:

At midnight on December	12,	the distance was		301;
"	"	21,	"	"	620;
"	"	24,	"	"	715;
"	"	26,	"	"	772;

and he has applied the ordinary method for interpolating the distance on 20th December at midnight. I shall use for the same purpose, the formula III.

In order that the first term of the series for epochs should be unity, the origin of the co-ordinates has to be taken as of 11th December; and the two series will then correspond as under:

Epochs of time-intervals:	1.	10.	13.	15.
Distances :	301.	620.	715.	772.

The epoch to be interpolated corresponds, then, to 9 in the series; but for the application of the formula, we have first to ascertain the values of b, c, and d corresponding to the epochs 2; 3; 4, respectively; the value of a is already known to be 301. For this purpose we construct with the three other distances given, as many equations as there are unknown quantities, substituting in each the successive values of n as 620; 715; 772, respectively, as under; and then eliminating the quantities in question:

$$n=10.;\ \text{and}\ 620=\frac{9.8.7}{2.3.}.d-\frac{9.8.6}{2}.c+\frac{9.7.6}{2}.b-\frac{8.7.6}{2.3.}.301;$$

$$n=13.;\ \text{and}\ 715=\frac{12.11.10}{2.3}.d-\frac{12.11.9}{2}.c+\frac{12.10.9}{2}.b-\frac{11.10.9}{2.3}.301;$$

$$n=15.;\ \text{and}\ 772=\frac{14.13.12}{2.3}.d-\frac{14.13.11}{2}.c+\frac{14.12.11}{2}.b-\frac{13.12.11}{2.3}.301;$$

The numerical transformations of these, result in three main equations, viz.

$$(\alpha).\quad 17476 = 84\,d - 216\,c + 189\,b;$$
$$(\beta).\quad 50380 = 220\,d - 594\,c + 540\,b;$$
$$(\gamma).\quad 86858 = 364\,d - 1001\,c + 924\,b;$$

Multiplying (α) by $4\frac{1}{3}$; and subtracting from (γ), we eliminate d; and leave

$$(\delta)\quad 11128\tfrac{2}{3} = 105\,b - 65\,c.$$

Again multiplying (α) by the fraction $\frac{5}{2}\frac{5}{1}$; subtracting from (β); and multiplying the remainder by $2\frac{1}{3}$, we obtain

$$(\varepsilon).\quad 10755\tfrac{5}{9} = 105\,b - 66\,c;$$

and subtracting this last from (δ), we eliminate b; and deduce

$$c = 372\tfrac{3}{9}.$$

By similar substitutions, $b = 336\frac{7}{6}\frac{7}{1}\frac{6}{5}$; and

$$d = 409\tfrac{2}{3}\tfrac{2}{5}.$$

With these values we can now interpolate any term. For the one in question we have $n = 9$; and $l = \frac{8.7.6}{2.3}.409\frac{2}{3}\frac{2}{5} - \frac{8.7.5}{2}.372\frac{3}{9}$ $+\frac{8.6.5}{2}.336\frac{7}{9}\frac{7}{4}\frac{6}{5} - \frac{7.6.5}{2.3}.301$; whence the distance required, or the 9th term, $(l) = 586\frac{3}{1}\frac{1}{6}\frac{1}{3}$ or 586·295. The result of Wallace, 586·3 may be said to be absolutely identical.

4. I shall give but one more example of this kind. In an experiment of Coulomb, it was observed that with ropes of 12·5, 20, and 28 lines in circumference, passing over a pulley of four inches diameter and strained with a constant weight, the rigidities were equivalent to 11; 27; and 50 pounds, respectively: what will be the equivalent rigidity, other things being the same, of a rope 16 lines in circumference?

Here we have the two series, corresponding as under:

	In.	In.	In.
Circumferences:	12·5.	20.	28.
do. divided by 1st term:	1.	1·6	2·24
Rigidities:	11 lb.	27 lb.	50 lb.

In this case, the value of a (formula II.) is known; the value of b and c are obtainable from the equations of 27lb. and 50lb. to the corresponding values of n; viz. 1·6 and 2·24 respectively. These being determined they are substituted in the same formula, taking also the value of n at 1·28 ($\frac{1}{1}\frac{2}{2}\frac{8}{5}$), the epoch of the required ordinate. The processes themselves are so purely artificial and so similar to what was given in the last example, that they need not be exhibited here. It is enough to say that they result in making $l = 17{\cdot}77$ lb.

Weisbach's method has given the same value of this term at 20·39lb.; which is manifestly erroneous and would accuse a convergence of a series which is plainly diverging. It could not by possibility be so much, even were the interpolated circumference

16·25 inches (the mean between 12·5 and 20), and the differences of the rigidities constant in the first place. I have not, however, farther investigated the causes of his error.

5. I shall terminate these numerical illustrations with one more instance; in which both coördinates undergo interpolation, simultaneously. This, as it is one of the most complicated cases, is also one of the most interesting applications of the formula which developes itself here with remarkable simplicity. The instance is the solstitial observation of Gassendi, in 1636, at Marseilles, of the shadow of a lofty gnomon. Supposing the gnomon divided into 89428 parts, he found the length of the shadow at noon on the respective days, as under:

Epochs.	June 19.	June 20.	June 21.	June 22.
Corresponding values of n.	1.	2.	3.	4.
Lengths of shadow:	31766	31753	31751	31759

The question is to ascertain by interpolation at what moment the shadow was the shortest; which is also the moment of the solstice.

It has been usual in questions similar to this, in order to avoid the resolution of equations of a degree higher than the second, not to involve all the terms at once; but to group them into sets, the mean of whose several results may be taken as the absolute one. It need hardly be said that such grouping and permutation lead only to partial solutions, which however approximate, do not exhaust at once all the elements given. The present method allows of the simultaneous employment of all these: but as there are only materials for one equation, while there are two unknown quantities, resort must afterwards be had to the higher analysis to determine when the shadow-length and the corresponding ordinate becomes a minimum.

Taking, then, our formula III, and leaving n in that, as unknown; and substituting for a, b, c, and d, respectively, the values of the shadow-lengths in the order given above; and executing the necessary numerical transformations, we obtain the sum of the terms which, when the unknown quantity is a minimum, must be equal to zero; as under,

$$-\tfrac{1}{6}n^3+6\tfrac{1}{2}n^2-31\tfrac{1}{3}n+31791=0.$$

Changing the signs, and differentiating in the ordinary methods, this leads to an equation of the second degree, viz.

$$n^2-26n=-62\tfrac{2}{3},$$

whose resolution gives a positive value of $n=2{\cdot}69$; which is to be counted in the direct order from 18th June, and corresponds of course with June 20^d, 16^h, $33^m{\cdot}6$, as the moment of the solstice.

It is evident that the order in which the terms should be taken in a case of this kind, is quite arbitrary and ought to be immaterial to the result. Accordingly, if we invert the present order and

assign to a, b, c, and d, the values of the shadow-lengths, counting from 22 June; and execute the numerical transformations as before, we shall have the terms to be made equal to zero, as under:

$$\tfrac{1}{6}n^3 + 4n^2 - 21\tfrac{1}{6}n + 31776 = 0.$$

Differentiating, we have

$$n^2 + 16n = 42\tfrac{1}{3}$$

and $n = 2{\cdot}31$; which counting from 23 June, corresponds with June 20^d, 16^h, $33^m{\cdot}6$, as before.

The epochs obtained by Wallace, are, calculating by

1. the first, second and fourth terms, June 20^d, 17^h, 15^m: and
2. the first, third and fourth " " 20^d, 17^h, 25^m.

But I cannot consider the concurrence of these partial methods as comparable with a result from a general solution.

In point of fact, the present formula admits, from its geometric construction, of being applied to cases like this, with results approximate enough for most practical purposes and without any aid from the higher analysis at all,—a contingency where the ordinary formulæ fail. For instance, it is plain from the march of the terms just now given that they indicate points in the two arms of a parabola whose apex is the very solstitial point in question. In reality, these are not in the two arms of *one* parabola; but in the opposite arms of two parabolas of different parameters, whose axes and poles coincide. This condition, however, only affects the process, not the principle.

As we have only two points in either arm, we cannot interpolate nearer than by first differences that determine only a straight line—a path very variant from the hypothetical motion of the sun or the real motion of the earth. But as this motion is elliptical, and therefore subject to equation not higher than of the second degree, we may hence derive an approximate use of these differences to serve in solution.

Starting, then, on 19th June, with the series of shadow-lengths as abscissæ, the difference between the first and second terms is 13; which represents from the 19th to the 20th June, the measured change in declination *ascending*. Between the 21st and 22d June, the difference of the third and fourth term is 8; but the change is to declination *descending*. Between the 20th and 21st, the difference is only 2; and although it might by possibility be that the ascending declination (or descending series) was continued on to the 21st June, and that the turning point took place there or farther on, we are restrained from such an assumption from the large difference between the third and fourth terms, too great to consist with an incipient reversed motion. The crisis then must have occurred, as we have all along supposed, between the second and third term; and although this third term is yet less than the second, it bears in fact a contrary sign. The descend-

ing series and the curve corresponding to it, pass beyond the second term and meet the ascending ones through the third, in some stationary and tangential point whose abscissa is that of the solstice. The tangent at this point is, of course (i. e. its abscissa is) less than that of the third term: how much below, the negative differences of declination afford probable data for determining.

Having four abscissæ and three intervals, we have also for the variation in length of these abscissæ during the first interval, 13; and during the third, 8; as the actual motion is elliptical, the variation during the second, will be the square root of the difference of the other two (i. e. $\sqrt{13-8}=\sqrt{5}$;)$=2{\cdot}23$; stopping in an equation of the second degree, at the second decimal place. This is the whole change in declination between the second and third abscissa; and the difference of this ($2{\cdot}23$), and the apparent difference of the two abscissæ (2), is the distance in declination below the third: corresponding to an actual abscissa of the solstitial point of $(31751-0{\cdot}23)=31750{\cdot}77$ parts. With this determination, the case is removed from its anomaly; and there is no obstacle to the employment of the formula, involving all four terms, to find the corresponding ordinate. With the ordinary methods, there would still be required the resolution of a cubic equation; under the present formula, all terms containing a power of n higher than the second, are eliminated.

It is manifest that as we have now the absolute numerical value of the abscissa at the point required, the sum of the terms containing n (the ordinate of the same point), which for differentiating was made equal to zero, becomes now equal to the said abscissa. So that, recurring to the last solution, we have thence these two equations:

$$\tfrac{1}{6}n^3-6'n^2+31\tfrac{1}{3}n-31791=31750{\cdot}77;$$
$$\tfrac{1}{6}n^3+4\ n^2-21\tfrac{1}{6}n+31776=31750{\cdot}77.$$

Arranging all the terms involving n, on one side, we have

$$\tfrac{1}{6}n^3-6\tfrac{1}{2}n^2+31\tfrac{1}{3}n=40{\cdot}23;$$
$$\tfrac{1}{6}n^3+4\ n^2-21\tfrac{1}{6}n=-25{\cdot}23.$$

Subtracting the latter from the former, and then changing the signs, we have left

$$10\tfrac{1}{2}n^2+52\tfrac{1}{2}n=-65{\cdot}46$$

and dividing $n^2+5n=-6{\cdot}23$; an equation with no power of n higher than the second, and which, although its second member has an apparently negative sign, leads yet to a positive result, viz. $n=2{\cdot}64$; corresponding when reduced to time to June 20^{d}, 15^{h}, $21^{\mathrm{m}}{\cdot}6$, a result sufficiently approximate to be employed.

Such are the examples and illustrations which seemed to me of sufficient interest to be connected with the formula and with this account of it.

Art. III.—*On the Fossil Remains of Birds collected in various parts of New Zealand by Mr. Walter Mantell, of Wellington;* by Gideon Algernon Mantell, Esq., LL.D., F.R.S., Vice President of the Geological Society.

From the Quart. Jour. Geol. Soc., London, No. 15, Aug., 1848.

It is not a little remarkable that one of the most interesting palæontological discoveries of our times, namely, the former existence of a race of colossal Ostrich-like birds in the islands of New Zealand, though made in a British colony, and announced to the scientific world by an eminent British physiologist, has not hitherto been brought under the immediate notice of the Geological Society of London. I therefore consider myself particularly fortunate in having an opportunity, through the researches of my eldest son, Mr. Walter Mantell, of submitting for the examation of the Fellows of this Society, perhaps the most extraordinary collection of the fossil remains of struthious birds that has ever been transmitted to Europe, containing the crania and mandibles, egg-shells, and bones, of several genera and species, most of which, if not all, have probably been long extinct.

The first relic of this kind was made known to European naturalists by Pofessor Owen, in 1839. It consisted of the shaft of a femur or thigh-bone, but a few inches long, and with both of its extremities wanting; and this fragment so much resembled in its general appearance the marrow-bone of an ox, as actually to have been regarded as such by more than one eminent naturalist of this metropolis. If I were required to select from the numerous and important inductions of palæontology, the one which of all others presents the most striking and triumphant instance of the sagacious application of the principles of the correlation of organic structure enunciated by the illustrious Cuvier,—the one that may be regarded as the *experimentum crucis* of the Cuvierian philosophy,—I would unhesitatingly adduce the interpretation of this fragment of bone. I know not among all the marvels which palæontology has revealed to us, a more brilliant example of successful philosophical induction—the felicitous prediction of genius enlightened by profound scientific knowledge.

The specimen was put into Professor Owen's hands for examination, with the statement "that it was found in New Zealand, where the natives have a tradition that it belonged to a bird of the Eagle kind which had become extinct, and to which they gave the name of Movie;" and from this mere fragment, and with this meagre history, the Hunterian professor arrived at the conclusion, "that there existed, and perhaps still exists in those distant islands, a race of struthious birds of larger and more colossal stature than the Ostrich or any other known species." This inference was based on the peculiar character of the cancel-

lated structure of the bone, which differs from that of mammalia, and most closely resembles that of the Ostrich. And so confident was Professor Owen of the soundness of his inductions, that he boldly added, "so far as my skill in interpreting an osseous fragment may be credited, I am willing to risk the reputation for it on this statement;" and he further remarks, "The discovery of a relic of a large struthious bird in New Zealand is one of peculiar interest, on account of the remarkable character of the existing fauna of those islands, which still include one of the most extraordinary and anomalous genera of the struthious order, the *Apteryx;* and because of the close analogy which the event indicated by the present relic offers to the extinction of the Dodo of the island of Mauritius. So far as a judgment can be formed from a single fragment, it seems probable that the colossal bird of New Zealand, if it prove to be extinct, presented proportions more nearly resembling those of the Dodo, than of any of the existing *Struthionidæ*." In 1843 the correctness of these views was confirmed in every essential particular by a large collection of bones obtained by the Rev. W. Williams and transmitted to the Dean of Westminster; and still further corroborated by another interesting series brought to England in 1846 by Percy Earl, Esq.; and by the collection which forms the immediate subject of this communication.

My eldest son, who went to New Zealand in 1839, and settled at Wellington, in one of his earliest letters to me after his arrival, mentioned that a tradition was prevalent among the *Maories* or natives, that gigantic birds, taller than a man, were formerly abundant throughout the islands; and that some of the oldest of the natives averred that they had seen such birds; and that although much reduced in numbers, some of the race still existed in the unfrequented and inaccessible parts of the country. They called these birds *Moa*, and affirmed in proof of their statement, that enormous bones were occasionally met with in the mud and silt of the streams and rivers; but my son was unable to obtain any of the bones in question.

Upon learning from me of the discovery of the bone described by Professor Owen, he endeavored to obtain further information on this interesting subject; but until 1846, when he resigned an official situation, he was unable to follow up his inquiries with success. In the meanwhile the collections of the Rev. W. Williams, Mr. Percy Earl, and of other gentlemen, had furnished the materials from which Professor Owen drew up his two celebrated memoirs on the *Dinornis*, an extinct genus of tridactyle Struthious Birds, which were published in the third volume of the Transactions of the Zoological Society.

In 1846, and the commencement of 1847, my son explored every known locality of these relics in the North Island within

his reach, and went into the interior of the country and located with the natives, for the purpose of collecting specimens of the then unknown parts of the skeletons, and of ascertaining whether any of these gigantic birds were still in existence; resolving, if there appeared to be even a remote chance of this being the case, to penetrate farther into the interior and obtain one alive. The information he gathered from the natives offered no encouragement to follow up the pursuit, at least in that part of the country, but tended to confirm the idea that the gigantic struthious birds had become extinct, the last of the race having, like the Dodo, been destroyed by man within a comparatively recent period; and that if any of the species whose bones are found in a fossil state are still living, it is probable they will be those of small size, and related to the *Apteryx*, the living diminutive representative of the colossal bipeds that once trod the soil of New Zealand.

With these introductory remarks, which appeared to me necessary to place the history of the discovery in a clear point of view, I propose, first, to notice the geological conditions under which these fossil bones appear to have been accumulated; secondly, to describe in general terms the most remarkable features of the collection before us; and lastly, to offer some observations on the bearing of these facts on that difficult problem, that "*mystery of mysteries*," as it has been emphatically termed by Sir John Herschel, the appearance and extinction of certain types of organic beings on the surface of the globe.

I. *Geological position of the deposits in which the bones occur.*—In attempting to arrive at a correct knowledge of the relative geological age of the deposit in which the bones sent to this country were found imbedded, I have experienced considerable difficulty, in consequence of the unsettled state of the orthography of the various localities, and also from the indefinite manner in which the collectors describe the places whence they obtained the specimens. Unfortunately the letter from my son containing details of this nature, and to which in his subsequent correspondence he refers me for the necessary information, has not reached me. I endeavored to mark on a map of New Zealand all the localities whence bones had been obtained, but several places mentioned by the collectors are not inserted. I will therefore briefly state the circumstances under which the bones are described as occurring by the gentlemen who have transmitted them to this country.

The Rev. W. Williams, in his letter of Feb., 1842, states, "that none of the bones have been found on dry land, but are all of them from the beds and banks of freshwater rivers, buried only a little distance in the mud. The largest number are from a small stream in Poverty Bay, the River Wairoa, and from many

inconsiderable streams, all of which are in immediate connection with hills of some altitude."

A mutilated cranium, described by Professor Owen,* was obtained by Mr. Williams from the bed of a mountain-stream descending to the coast of Poverty Bay in the North Island. Another, sent over by W. Swainson, Esq.,† is from the vicinity of the Bay of Islands. "Both of these have a ferruginous tint and great weight, arising from an infiltration of peroxyd of iron; but the cancelli of the bone contain only a little of the dry powdery alluvium of the stream into which the specimens have been washed."‡

The Rev. W. Colenso, who in 1841–1842 accompanied Mr. Williams in search of the Moa, has given a very interesting account of the circumstances under which the bones were procured in the bed of the Waiapu river by the natives, by whom they were sought for to make fish-hooks.§ He states, that travelling southward from Poverty Bay, he came within sight of *Wakapunake*, the mountain celebrated among the natives as the residence of the surviving Moas; but no bones were obtained from thence. "The Maories affirmed that Moas lived there, but admitted that no one had seen any of these gigantic bipeds. The Moa's bones were to be found only after the floods occasioned by heavy rains, when they were to be seen after the waters subsided, washed up on the banks of gravel and mud on the river-side; but none were then to be procured. I offered large rewards for any that should be met with, and directed them to be taken to Mr. Williams in Poverty Bay. At the base of the mountain is the river *Wangarao*, which is a branch of the Wairoa, and runs into Hawke's Bay; and down this we paddled for some distance, but perceived no bones. Finding that we were willing to pay largely for specimens, a hundred persons set about hunting for them, and brought those they collected to Mr. Williams." Mr. Colenso states, that hitherto (in 1842) bones have only been found within the waters and channels of those rivers which discharge themselves into the southern ocean between the East Cape and the south head of Hawke's Bay, on the east coast of the North Island. They only occur on the banks of gravel, &c. in the shallowest parts of the rivers after floods occasioned by heavy rains, and when the waters have subsided to their usual level.

"These rivers are in several places at a considerable depth below the present surface of the soil, often possessing a great inclination, as it is at once perceived by the rapidity of their currents. They have all a delta of greater or less extent at their mouths, from an inspection of which it is obvious that their channels

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* Zool. Trans., vol. iii, p. 308, pl. 38. † Ibid.
‡ Prof. Owen in Zool. Trans., vol iii, p. 308.
§ See Annals and Mag. of Nat. Hist., vol. xiv, New Series, p. 81.

have considerably changed. The rocks and strata in these localities indicate generally both secondary and tertiary formations; the former consisting of argillaceous schist, sandstone conglomerates, greensands, &c.; the latter of clay, marly *calcareous tufa*, sand, gravel, and alluvial deposits." The true situation of the Moa bones is not known with certainty, but Mr. Colenso infers that they are found in the lowermost tertiary deposit. The localities mentioned by Mr. Colenso lie to the east of the volcanic chain of Tongariro, and the rivers probably have their origin on the flanks of that volcanic region.

The collection formed by Dr. Mackellar was from the Middle Island, from a superficial turbary formation on the coast, which was submerged at high tide, and is near the settlement at *Waikawaite*. Mr. Percy Earl, who obtained his specimens from the same locality, mentions that this deposit, which is overflowed by the sea at high tides, had been covered by a layer of sand and shingle; but this covering had been swept away by storm-waves a short time before his arrival, and a bed of black peat was exposed, from the surface of which bones projected; these and other specimens were procured by digging close to the surface, or at a moderate depth in the peat; they were all Dinornis' bones.*

The account given by the Rev. Mr. Taylor of Wanganui, a settlement on the western coast of the North Island, near the embouchure of the river of that name, lying to the south of Cape Egmont, as New Plymouth does to the north, is, in substance as follows:—

In 1843 he procured a collection of bones during a journey to Turakina (?),† from having observed a fragment of large bone, which induced him to inquire of the natives if such relics were to be met with. The natives pointed out to him several little hillocks of bones scattered here and there over the valley at the mouth of the river Whaingaihu (?) where the sand had drifted. Mr. Taylor describes these heaps as being composed of bones of several kinds of Moa, as though the flesh of the birds had been eaten, and the bones thrown indiscriminately together. The bones were in so friable a state that only the large ones would bear removal; the smaller ones pulverize in the hand, and below the surface the whole was a mass of decomposed bone. "The subsoil was a loamy marl, beneath which was a stratum of clay that chiefly forms the cliffs of this part of the western coast; it contains numerous marine shells, and closely resembles in appearance the *galt* of the southeast of England. I have no doubt it was when that loamy marl formed the surface-soil that the Moa lived; for although it is laid bare by the river side, yet in other parts *it is wholly covered by several strata of marine and fresh-*

* Zool. Trans., vol. iii. † Ibid, iii, 327.

water deposits. I have found the bones of the Moa in this bed, not only in other parts of the western, but also in the eastern coast, at the East Cape, and at Poverty Bay. I have not heard of this deposit having been noticed north of Turakina (?).*"

All the specimens sent from the localities above mentioned, with the exception of those from the South or Middle Island, are in the state of the mammalian bones that occur in the ancient alluvial deposits of England. They are permeated and colored more or less deeply by a solution of iron, and the cancelli are filled by the mud or silt in which they were found imbedded. They are but little water-worn, and have not suffered much abrasion; having, probably, been protected by the muscles and soft parts during their transport to the places where they were deposited. In short, their state of fossilization corroborates the accounts given of the nature of the alluvial bed from which they were procured; they strikingly resemble in this respect the bones of the Irish Elk, Mammoth, &c. of our diluvium.

But the bones collected by my son present a very different appearance from any previously received from New Zealand; instead of being of a dark color, heavy, and permeated by silt and iron, they are, on the contrary, light and porous, and of a delicate fawn-color; the most fragile processes being entire, and the articulating surfaces as smooth and uninjured as if prepared by the anatomist; *egg-shells*, *mandibles*, even the *bony rings of the air-tubes* are preserved. In their general aspect these bones most resemble those from Gaylenreuth and other ossiferous caverns. The state of preservation of these specimens is evidently due to the material in which they were imbedded, which is a loose volcanic sand, containing magnetic iron, crystals of hornblende and augite, &c., the detritus of augitic rocks and earthy tuff. This sand has filled all the cavities and cancelli that have external openings, but is in no instance consolidated or aggregated together; it is easily removed from the bones by shaking, or by a soft brush. A very few water-worn pebbles of volcanic rocks were the only extraneous bodies found in the sand: there are no vestiges of shells or mollusca of any kind; but there is in the collection a small *Area* imbedded in a sandy clay, and an ammonite coated with pyrites, so like a specimen of *A. biplex* from the Kimmeridge clay of England, as not to be distinguishable from a genuine British fossil.

The name of *Waingangoro*, the locality which my son mentions as that where he dug up the greater part of his collection, does not appear in the maps of New Zealand I have inspected; but from some incidental remarks in his letters, I have reason to infer that it is situated in the higher part of the valley of the

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* See Prof. Owen's Memoir on the Dinornis, Zool. Trans., vol. iii, p. 327.

Wanganui, a river which has its source in the volcanic regions of Mount Egmont. It was at the embouchure of the Wanganui that Mr. Taylor obtained the bones in his possession. It will be remembered that the streams which yielded the relics procured by Mr. Colenso and Mr. Williams, lie to the east of Tongariro, and probably originate in that elevated volcanic chain, many parts of which are above the line of perpetual snow. The specimens collected by my son were found imbedded in and filled with loose sand, at a considerable distance from the bed of the river; in no instance do they exhibit any traces of silt or fluviatile mud. My son mentions having on one occasion obtained bones from a potato-pit sunk by a native remote from any stream.*

With the view of elucidating these remarks, and the inferences I shall presently venture to suggest, I will here concisely describe the geological structure of New Zealand, on the authority of Dr. Dieffenbach. This country, which is situated between 30 and 50 degrees of south latitude, forms a group of mountainous islands nearly as large as England and Wales. Its geological structure is with difficulty determined, owing to the primeval forests which fringe the coast; and where these have been destroyed, by impenetrable thickets of esculent fern. The fundamental rock is everywhere clay-slate, which is frequently traversed by greenstone dykes, as at Fort Nicholson, Queen Charlotte's Sound, and Cloudy Bay. On the banks of the rivers Eritonga, Waibo, and along some parts of the sea-coast, *there are horizontal terraces of boulders of trap-rocks* 50 *feet high.* Anthracite coal crops out in the harbor of Wangarua; and there is a seam of the same mineral intercalated in the hard grey sandstone on the east coast of the Northern Island. On the west coast of the same, the limestone contains a few shells, as pecten, ostrea, terebratula, with an *Echinus spatangus.* The coasts are in many places fringed with recent horizontal sediments, consisting of loam with fragments of wood and fern, &c. The small rocky islands of trachyte off the coast of the Northern Island also *bear marks of wave-action to the height of* 100 *feet above the present sea-level.* In the interior of the Northern Island there is a lofty central group of volcanic mountains, some of the volcanos being still in activity: the ancient lava-streams appear to have been principally erupted from the base of the craters. The highest mountains are Tongariro, which is 6,000 feet, and Mount Egmont, 9,000 feet high. The loftiest summits are covered with perpetual snow. There are many lakes, which appear to occupy ancient craters.†

The occurrence of terraces of loam and gravel of comparatively recent date, at an elevation of from 50 to 100 feet above the sea, along the coasts of New Zealand, prove that a considerable change

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* Wonders of Geology, 6th edition, p. 129.
† British Association Reports for 1845.

in the relative level of the land and water has taken place since those terraces were deposited, and at no very remote period. The present rivers of the country are described as now cutting deeply the beds of volcanic detritus and silt in which the birds' bones are contained; and the latter are in some places covered by marine and freshwater deposits. The facts adduced appear to me confirmative of the opinion advanced by Mr. Colenso (in 1842), that the true situation of the ossiferous deposit is beneath the surface-soil of the fluviatile beds formed by the present rivers. In the more elevated regions the bone-deposit consists of pure volcanic sand and detritus; while in the low districts and along the coasts it is composed of fluviatile mud or silt, which in many places is covered by modern beds of shingle and gravel.

II. *Description of Mr. Walter Mantell's Collection.*—I will now describe in general terms the most interesting specimens in the collection formed by my son; the anatomical details, and the important physiological inferences resulting therefrom, will be laid before the Zoological Society by Professor Owen; to whom, as a tribute of respect due for his masterly interpretation of the bones previously transmitted from New Zealand, I have offered the examination and description of every object in the series that he may consider worthy his attention.

The specimens amount to between seven and eight hundred, and belong to birds of various sizes and periods of growth; some evidently of aged individuals, and others of very young animals, in which the epiphyses of the long bones are still distinct from the shaft. They were catalogued by my son as follows:—

Birds' bones.—*Crania and mandibles*, 19; vertebræ, 250; sterni, portions of, 7; pelves, more or less complete, 30; femora, 37; tibiæ, 42; fibulæ, 35; tarso-metatarsal, 40; phalangeal, 200; ungueal or claw-bones, 30; ribs, 30; *egg-shells*, fragments, 36 specimens.

Seals.—Jaws with teeth, portions of crania, vertebræ, ribs, scapulæ, bones of the extremities.

Terrestrial mammalia.—One femur.

The specimens received exceeded the number above specified, and with the exception of a few of the most fragile (and unfortunately the most precious, as, for example, the mandibles, pelves, sterni), arrived in an excellent state of preservation.

The birds' bones, so far as they have been hitherto examined by Professor Owen, are referable to five genera; the crania and mandibles of three of which were previously unknown.

1. *Dinornis.*—This name is now restricted by Professor Owen to the birds which possessed a skull and beak essentially different from any form either recent or fossil. Of this genus there is a nearly perfect cranium, with the upper mandible, and portions of two other skulls. The form of the cranium, especially of the

temporal and occipital regions, is wholly unlike any hitherto observed in the class of birds, and approaches that of reptiles. It is characterized by the nearly vertical occipital plane, the elevated position and form of the foramen magnum, and the great development below the occipital condyle, and the strong ridges which border the basi-occipital, and indicate a most extraordinary power in the muscles that moved the cranium. The temporal fossæ are very deep, and are strengthened by a prolongation of the mastoid process, which is united to the frontal, and forms what may be termed a lateral zygomatic arch. The tympanic bone has two distinct cusps for articulation with the double condyle of the os quadratum. The configuration of the upper mandible or beak (the lower one is unknown) is very peculiar, and has been aptly compared by Professor Owen to a cooper's adze; it is considered by him to have been especially adapted for grubbing up roots and tubers; we have evidence, in the powerful muscles attached to the occipital region, of its having been an instrument capable of being used with great force. There is a portion of the articular part of a large lower jaw, that probably belongs to *D. giganteus*.

To this genus belong many vertebræ of enormous size; ribs, bones of the pelvis, and hinder extremities, and some portions of sterni; they are referable to six or seven species, respectively named from their size and osteological character, *D. giganteus*, *D. robustus*, *D. ingens*, *D. casuarinus*, *D. geranoides*, *D. curtus*, *D. didiformis*.

Among the bones of the extremities of the large species, I would especially direct attention to the femur, tibia and fibula of a young bird. The femur is 14 inches long, 9 inches in circumference round the shaft, and 16 inches round the condyles. The tibia, in which the union of the epiphysis of the proximal extremity is still incomplete, is 30 inches long, 6 inches in circumference at the shaft, and 14 at the condyles. The tibia of a much younger bird gives still more colossal proportions: for it measures 12 inches in circumference at the condyles, and yet the distal epiphysis, which is always rapidly anchylosed to the shaft in birds, is still distinct. The proximal extremities of other tibiæ are 17 inches in circumference; and there are fragments of shafts 8 inches round.

2. *Palapteryx*.—In this genus the skull differs essentially from that of the Dinornis; the occipital region is narrower; the foramen magnum is situated in the centre, which in the Dinornis is occupied by the condyle; the basi-occipital is not so much developed; and there are other osteological peculiarities which I need not detail. The rostral part of both mandibles is preserved, and shows an approach to the Dromaius or Emeu. The ethmoid cavities, or upper nostrils of the skull, are very large, as in the

Apteryx, a peculiarity denoting a remarkable development of the organs of smell.

Of this genus there are imperfect crania, mandibles, vertebræ, bones of the extremities, &c.

3. *Aptornis.*—Among the bones of small size, those for example that are comparable in magnitude to the skeletons of the Bustard and Apteryx, there are several tarso-metatarsals, femora, tibiæ, pelves, &c., which indicate a new tetradactyle genus, very closely allied to the living struthious bird of New Zealand, the Apteryx. Some of these bones are referable to the *D. otidiformis*, or Bustard-like Moa, of Professor Owen's second memoir: I believe the name of *Aptornis* will be assigned to this genus.

The other birds' bones belong to genera and species of which there are still living forms in New Zealand and Australia.

4. *Notornis.*—This genus is established by Professor Owen from the skulls, and upper and lower mandibles, vertebræ and bones of the extremities, of birds belonging to the *Rallidæ* or Rails; and closely allied to the living *Brachypterix*, a species of Coot or Water-hen peculiar to New Zealand. The mandibles are sharp like those of the Raven, but are more compressed laterally; the cranium presents some interesting anatomical characters. The original was of the size of a bustard.

5. *Nestor.*—The collection contains two upper mandibles of a species of *Nestor*, a genus of nocturnal owl-like parrots, of which only two living species are known. One of these (*Nestor hypopolius* of Mr. Gould) is restricted to New Zealand; and the other (*N. productus*) to Philip Island, which is not more than five miles in extent; and Mr. Gould remarks that "so exclusively is the *Nestor productus* confined to this isolated spot, that many persons who have resided in Norfolk Island for many years have assured me that its occurrence there is unknown, although the distance from one island to the other is not more than three or four miles."*

Such is the brief account of the birds' bones that have been accurately examined by Professor Owen; but it is probable, when the vertebræ and other specimens that have as yet been only cursorily inspected are carefully compared with recent skeletons, other species and genera will be detected. Some of the vertebræ appear to belong to the existing species of *Apteryx*, *A. australis*.

Egg-shells.—The fragments of egg-shells imbedded in the ossiferous deposits had escaped the notice of all previous observers, which is not surprising, for they are of small size and of very rare occurrence. My son, in all his wanderings, only procured between thirty and forty pieces. As these precious relics will shortly be described by Professor Owen, I will only mention that

* Mr. Gould's Birds of Australia.

the edges of most of them are rounded, as if water-worn. They belong to different species, or perhaps genera: some of them are smooth, but others have the external surface marked with short interrupted linear grooves, resembling the eggs of some of the Struthionidæ, but still presenting very characteristic peculiarities.

No vestiges of the bones of the wings have been detected.

Seals.—The remaining part of the collection consists of jaws with teeth, scapulæ, vertebræ, ribs, femora, and other bones, of a species of large seal; whether distinct from the two kinds (*Phoca leptonyx* and *P. leonina*) that inhabit the southern seas, and occasionally visit the shores of New Zealand, I have not yet been able to determine. The bones were found mixed indiscriminately with those of the birds, and are filled with volcanic sand.

Femur of a Carnivore.—One other relic must be specified, *the femur of a dog;* the sole fossil bone of a terrestrial quadruped that has hitherto been discovered in the ossiferous deposits of New Zealand.

Burnt Moa, and Human bones.—I must not omit to mention a very remarkable incident. In one spot the natives pointed out to my son some little mounds covered with herbage, as containing bones, the refuse of feasts made by their ancestors; and upon digging into these hillocks they were found to be made up of burnt bones. These consisted of *Moas', dogs' and human bones* promiscuously intermingled. These bones, which have evidently been subjected to the action of fire, contain no traces whatever either of the earthy powder or ferruginous impregnation so constant in the fossil bones from the fluviatile silt, nor of the volcanic sand with which all the bones collected by my son are more or less permeated. Mr. Taylor (*ante* p. 32) mentions having found similar heaps of bones in the valley of the Whaingaihu, "*as though the flesh of the birds had been eaten, and the bones thrown indiscriminately together.*" If such was the origin of these heaps of bones, and they are to be regarded as the rejectamenta of the feasts of the aborigines, the practice of cannibalism by the New Zealanders will appear to have been of very ancient date, and not to have originated from the want of animal food on account of the extinction of the Moas, as Professor Owen so ingeniously and indulgently suggested in extenuation of this horrid practice by so intelligent a race as the New Zealanders.

III. *General Conclusions.*—From the scattered facts which I have thus brought together in order to throw some light on a question of such deep palæontological interest—upon the principle that the feeblest rays, when concentrated into a focus, will produce some degree of illumination—I think we may safely infer that the islands of New Zealand were densely peopled at a period geologically recent, by tribes of gigantic ostrich-like birds, of species and genera which have long since been obliterated

from the face of the earth; and that subsequently to this "*Age of Struthionidæ*," the land has undergone those physical changes, by which the areas occupied by the ornithic ossiferous deposits, and the beds of shingle and loam, which now form terraces from 50 to 100 feet above the sea-level, were elevated to their present positions. This inference seems to be corroborated by the fact that the existing mountain-torrents and rivers flow in deep channels which they have eroded in these pleistocene deposits; in like manner as the rivers of Auvergne have excavated their course through the mammiferous tertiary strata of that country.

The accounts given by Mr. Colenso, the Rev. H. Taylor and others, of the exposure of the bone-bed in the channels of the mountain-streams, and of the bones being left on the river-shoals after heavy floods, remind us of the conditions under which the mammalian fossils of the Sub-Himalayas were first brought under the notice of our eminent countrymen, Major Cautley and Dr. Falconer. And in New Zealand, as in India, the fossil remains of extinct animals are associated with those of existing genera; and the land is still inhabited by diminutive representative forms of the colossal beings which flourished in the pleistocene, or early human epoch; for the Apteryx and the Porphurio may be regarded as the living types of the Moa and the Notornis.

I do not deem it necessary to enlarge on the question whether the Dinornis and Palapteryx still exist in New Zealand; on this point I would only remark, that Mr. Colenso, who was the *first* observer that investigated the nature of the fossil remains with due care and the requisite scientific knowledge, (having determined the struthious affinities of the birds to which the bones belonged, and pointed out their remarkable characters, ere any intelligence could have reached him of the result of Professor Owen's examination of the specimens transmitted to this country,) has given, in his masterly paper before quoted, very cogent reasons for the belief that none of the true Moas exist, though it is probable the last of the race were exterminated by the early inhabitants of these islands.

But whatever may be the result of future researches as to the relative age of the ossiferous deposits, or the existence or extinction of the colossal bipeds whose relics are before us, this fact cannot be questioned—the vast preponderance of the class of birds which prevailed (and still prevails) in the fauna of New Zealand, to the almost entire exclusion of mammalia and reptiles. Any palæontologist who saw the entire collection formed by my son alone, could not but feel surprise at its extent and variety. I may venture to affirm that such an assemblage of the fossil bones of birds was never before seen in Europe—nearly one thousand specimens collected from various parts of the country, with scarcely any intermixture of those of any other class: it is a phe-

nomenon as marvelous as the exclusively reptilian character of the fauna of the Wealden epoch. In fact, New Zealand at the present time, as Dr. Dieffenbach observes, offers the most striking instance of an acknowledged fact in every branch of natural history, namely, that different areas of dry land are endowed with peculiar forms of animal and vegetable life; centres or foci of creation, so to speak, of certain organic types. And this organic law, with the effects of which, in the palæozoic and secondary ages, our geological researches have made us familiar, appears to have continued in unabated energy to the present moment. In fact, the most remarkable apparent anomalies in the terrestrial faunas and floras of the secondary epochs are not without modern parallels.

Thus New Zealand, with its peculiar flora, characterized by the predominance of ferns, club-mosses, &c., to the almost entire exclusion of the gramineæ,—and its fauna, comprising but two or three mammals and reptiles,—and the enormous development of the class of birds,—presents a general correspondence with the lands of the carboniferous and triassic epochs.

Australia and Van Diemen's Land possess a flora equally peculiar and extraordinary, and a fauna unlike that of any other part of the world, including some of the most anomalous of existing forms, as for example that marvelous creature the Ornithorhynchus. These countries, in the abundance and variety of the Cycadeacæ, Araucariæ, &c.—in the marsupial character of the great proportion of the mammalia—and in the Terebratulæ and Trigoniæ, and the Cestracion fishes which swarm in the seas that wash their shores, approximate in their organic relations more nearly to those ancient lands of which the Stonesfield oolites are the debris, than to any of the present regions of the earth.

Lastly, we have a reflected image, as it were, of the "*Age of Reptiles*" of the secondary formations, in the exclusively reptilian character of the quadrupeds of the Galapagos Islands, one species of mouse being the only indigenous mammalian. This Archipelago is a group of volcanic islands situated under the equator, between five and six hundred miles westward of the American coast. "It is," observes Mr. Darwin in his delightful Journal, "a little world within itself; most of the organic productions are aboriginal creations found nowhere else. Seeing every height crowned with its crater, and the boundaries of most of the lava-streams still distinct, we are led to believe that within a period geologically recent, the unbroken ocean was here spread out." These islands swarm with herbivorous marine and terrestrial reptiles allied to the Iguanidæ, which are known in no other part of of the world; and they are as completely distinct from all other existing reptiles, as are the extinct Iguanodon and Hylæosaurus.

The flora too contains more than a hundred plants unknown elsewhere. There is not a fauna or flora in any of the ancient geological periods that presents greater anomalies. Mr. Darwin emphatically remarks, that "when we consider the well-beaten paths made by the thousands of huge tortoises with which these islands are traversed,—the many turtles,—the great warrens of the terrestrial Amblyrhynchi, and the groups of marine species basking on the coast-rocks of every island of this Archipelago,—we must admit that there is no other quarter of the world where the Order of Reptiles replaces the herbivorous mammalia in so extraordinary a manner. The geologist on hearing this will probably refer back his mind to those Secondary Epochs, when saurians, some herbivorous, some carnivorous, and of colossal dimensions, swarmed on the lands and in the seas. It is therefore worthy his especial observation that this Archipelago, instead of possessing a humid climate and a rank vegetation, must be considered as extremely arid, and for an equatorial climate remarkably temperate."*

I have endeavored to express in the annexed table the organic relations between the countries above mentioned and their geological analogues.

MODERN EPOCH.	SECONDARY EPOCHS.
New Zealand. Predominance of Ferns, Lycopodiaceæ and other Cryptogamia. Gigantic Birds. Mammalia absent.	Countries of the Carboniferous and Triassic periods as indicated by fossil remains.
Australia. Cycadeaceous Plants. Marsupial Mammalia.	The lands whence the Stonesfield and Carboniferous oolitic strata were derived.
The Galapagos Islands. Predominance of Reptiles. Herbivorous, terrestrial and marine Saurians and Chelonians.	The country of the Iguanodon, and the regions that supplied the detritus that formed the fluvio-marine secondary strata.

In this point of view the "*Age of Reptiles*" may be considered as merely disclosing an exaggerated effect of the organic law of creation, which imparted to the fauna of the Galapagos Islands its reptilian character. In Australia, and in the Oolitic lands, the mammalian fauna assumed the marsupial type. In New Zealand, and in the Triassic countries, the ornithic vertebrata predominated.

If the ancient philosophers, ere the discoveries of Columbus had opened the New World to the European mind, had found in a fossil state such collocations of the remains of animals and plants as are presented by New Zealand, Australia, and the Galapagos Islands, how impossible would it have been for them, by any

* 'Journal of a Voyage round the World,' chap. xvii.

comparison with existing nature within their circumscribed geographical boundary, to have conceived the possibility of such assemblages of animated beings existing contemporaneously with themselves! In fact, the present geographical distribution of peculiar types of terrestrial animals and plants, affords as many anomalies in the relative predominance of different classes and orders, as are to be found in the vestiges of the earlier ages of our planet.

From these considerations I think we must conclude, that throughout all geological time the changes on the earth's surface, and the appearance and extinction of peculiar types of animals and plants, have been governed by the same physical and organic laws; and that the paroxysmal terrestrial disturbances, though apparently in the earlier ages involving larger areas, and operating with greater energy than the volcanic and subterranean action of modern times, did not affect the established order of organic life upon the surface of the globe; and that throughout the innumerable ages indicated by the sedimentary formations, there was at no period a greater anomaly in the assemblages of certain types of the animal and vegetable kingdoms than exist at the present time.

Additional Remarks on the Geological Position of the Deposits in New Zealand which contain Bones of Birds; by Gideon Algernon Mantell, Esq., LL.D., F.R.S., &c.

Since I had the honor of communicating to the Geological Society a notice of the collection of fossil bones of birds from New Zealand, I have received a letter from Mr. Walter Mantell, dated Wellington, June 18, 1847, containing some details respecting the bone deposits and the strata with which they are associated, which are of considerable interest, and confirm in every essential particular the conclusions suggested in my former communication. The following are extracts from my son's letter:—

"The principal part of the best specimens I have transmitted to you, I obtained from near the embouchure of a stream called Waingongoro, which lies about a mile and a half south of Waimate in the Ngátirúanúi district. The country hereabout is an elevated table-land, with deep tortuous gullies, through which the torrents and streams take their course to the sea. That of Waingongoro, which is as tortuous as any of them, appears to rise in Mount Egmont (the volcanic ridge which is 9000 feet high); indeed it must have its source there, or in the short chain of hills which lies between that mountain and the coast in a westerly direction; for in returning to New Plymouth by the mountain road—a forest-track at the back of the volcanic ridge—I must have crossed it, did it rise elsewhere. The Waingongoro evidently discharged itself at some distant period into the sea, far from its present embouchure, as is proved by the existence of a line of cliffs which

extends inland, and has clearly been produced by the eroding action of the river. Driven from its course, probably by a change in the relative level of the land and sea, it has formed its present channel, which cuts through a hundred feet of loose conglomerate, overlying a bed of finely laminated sand, and containing wood in a very recent state,—so recent as to bear cutting with a knife.

"The conglomerate is composed of an infinite variety of volcanic rocks, with numerous immense rounded masses of the same kind. The clay abounds in marine shells, all of existing species (?); the upper layers contain but few shells, but the lowermost abound in them, and they are in a perfect state—not drifted shells. In a stratum of sand at Wanganui the shells of a sandy bottomed sea are found, with some fragments of large Nautili.

"Between Takikau and Ohawetokotoko there is a wide flat of undulating sand, about two hundred yards across. On my first visit the surface was covered with bones of men, moas and seals, &c., which had been overhauled by the Rev. R. Taylor. I had some deep openings made near the base of the ancient cliffs, under the Pa Ohawe; and at the same level as that on which were the strewn fragments of bones I have mentioned, I came to the regular bone-deposit. The bones were mostly perfect in shape, but so soft, that if grasped strongly they would change, as if by magic, into clay. Unfortunately the natives soon caught sight of my operations, and came down the shoals, trampling on the bones I had carefully extracted and lain out to dry. My patience was tried to the utmost, and to avoid blows I was obliged to retreat and leave them in full possession of the field; and to digging they went in right earnest, and quickly made sad havoc. No sooner was a bone perceived than a dozen pounced upon it, and began scratching away the sand as if for their lives; and the bone was of course smashed to pieces. I am only surprised that I ultimately succeeded in getting any entire.

"The natives affirm that this sand-flat to Rangatapu was one of the places first dwelt upon by their ancestors; and this seems not unlikely, for in digging in various places I found small circular beds of ashes and charcoal and bones, very ancient, and such as are generally left by the native fires that have been long lighted in the same spot. Fragments of obsidian, native flint, two fishing-line stones and a whalebone *meri* (a sort of weapon) were also dug up. The natives told me, and their assertion was borne out by the appearance of the place, that within their memory the entire area had been covered by drift-sand; in fact, the bones seemed always to be imbedded on or beneath an old surface-level. Columns of vertebræ when uncovered were lying *in situ* and perfect, with, in rare instances, skull and pelvis; but to preserve these precious relics was impossible while beset with the hordes of natives; and I could not drive or bribe them away.

"The largest femur, tibia and fibula were lying in their natural connection—the leg slightly bent at the knee; a chain of vertebræ of the largest size was discovered near them, and I doubt not the whole belonged to the same colossal bird. You will readily imagine how exasperating it was to me to see specimen after specimen destroyed before my eyes, with no possibiliy of preventing it. From your ignorance

of the excessive obstinacy and mulishness of the natives, I fear your indignation will be directed against me; but if so, let me assure you, you are indeed in error. All that man could do I did to dissuade them from turning oryctologists or palæornithists; but to no purpose. Men, women and children resolutely dashed at every bone that appeared when the sand was removed; and if they listened for a moment to my entreaties and remonstrances, it was but to return with renewed vigor to the work of destruction.

"Mixed with the bones, but exceedingly rare, were the fragments of egg-shells, of which I sent you my then best specimens by post last April. I have also found six oval rings and one broad circular ring of the trachea. In coming down from Ngamotu I discovered a few more remains of eggs; one fragment is four inches long, and gives a good chord by which to estimate the size of the original: as a rough guess, I may say that a common hat would have served as an egg-cup for it: what a loss for the breakfast-table! And if native traditions are worthy of credit, the ladies have cause to mourn the extinction (?) of the Dinornis: the long feathers of its crest were by their remote ancestors prized above all other ornaments; those of the white crane, which now bear the highest value, were mere pigeons' feathers in comparison."

I have given these extracts without correction or comment, as they were written by my son for my private information, that I might not weaken the graphic description of the exhumation of the bones exhibited and described at the last meeting of the Society. There are still some details required to render it certain that the bone-bed is always intercalated, when not laid bare by modern denuding causes, between the blue clay with recent marine shells and the conglomerate of volcanic pebbles and boulders which forms a bed of from fifty to a hundred feet thick; but so far as I can interpret my son's meaning, and upon comparison of his statements with those of Mr. Colenso and others, I conclude that such is its true geological position. There is also some doubt whether in the heaps of ancient native fires which contain bones of man, dog, and moa, those of the colossal birds may not have been introduced by accident, and their charred appearance have been occasioned by drying, from exposure to the air and sun; but it must be remarked that these specimens never contain any of the sand in which they were imbedded, as the other examples do. These and other points will, I doubt not, be satisfactorily elucidated ere long, now that the collecting of the bones of the extinct birds of New Zealand is so earnestly and systematically pursued. In the meanwhile, the imperfect and hasty sketches of my son which I have placed before the Society, will not, I trust, be deemed altogether unworthy attention.

19, Chester Square, Pimlico.

Art. IV.—*Parallelism of the Palæozoic Formations of North America, with those of Europe;* by Ed. de Verneuil.

(Continued from pp. 183, and 370, vol. v.)

Carboniferous System.—Of all the principal divisions of which the palæozoic formation in America is composed, the Carboniferous system is that which is best defined, and has the most characters in common with European deposits of the same age.* It includes two or three stages, according as it is considered in the eastern or western states of the Union. It commences below by a micaceous psammite which so much resembles the rocks of the Portage [Chemung] group, that they have been completely assimilated.† The geologists who have attempted to show the parallelism of the American formations with those of Europe, have thus referred to the Devonian system those sandstones so well known in the states of Ohio and Indiana under the name of fine-grained sandstone, or Waverly series. The examinations which we have made to the south of Cleveland, in the state of Ohio, the fossils which we have found near Medina,‡ Cuyahoga and Newark, Ohio, have convinced us that a great part of these sandstones belong really to the Carboniferous system. The lower beds only may represent the Devonian stage of Portage, but as the rocks of this group completely resemble those which we unite with the Carboniferous system, and as in the state of Ohio they do not contain fossils, it will be understood that it is almost impossible to distinguish, in the sandstones of Waverly, those which are the prolongation of the beds of Portage from those which incontestibly belong to the Carboniferous system.§

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* In the different parts of America through which we have travelled, we have always readily distinguished it by its fossils, and have verified the truth of what we said seven years since, upon the importance of the limit which separates it from the lower formations. (Bull. de la Soc. Geol., vol. xi, p. 166.)

† We have brought from Cuyahoga and from Medina, Ohio, psammites with *Productus*, which it is almost impossible to distinguish mineralogically from specimens found at the Falls of Portage, N. Y.

‡ We are indebted to our colleague, Mr. W. C. Redfield, for directions in finding fossils at this locality.

§ [It appears to us that here is an admission somewhat at variance with the proposition at the commencement of the article. If the Carboniferous System is so well defined and characterized, there is no need of questioning the line of demarkation between the Portage and Chemung group, which are of admitted Devonian age, and the Carboniferous sandstones. The truth, however, is, that there is no well defined line of separation between the Chemung rocks of New York and the sandstones of Ohio and Indiana, which contain Carboniferous fossils. The error of American geologists, who have attempted to compare our formations with those of Europe, has been in this instance that of regarding the great carboniferous limestone as forming the basis of that system, including all the strata below in Devonian and Silurian. We have, in fact, been looking for great lithological changes and topographical features at the limits between two great systems, but as they are now divided, these great features are more frequently observed in the midst of a system than at its termination or commencement.—James Hall.]

If in Ohio, at the base of what is called the fine-grained or Waverly sandstones, there exists some representation of the Devonian beds, it is no longer so farther west. In the states of Indiana, Kentucky and Tennessee, the Carboniferous system comprises all the micaceous sandstones as far as the black slates, their lower beds including true Carboniferous species, such as the *Spirifer striatus*, *Productus punctatus*, &c.* In Tennessee a very abundant siliceous matter appears to have penetrated the sandstones, and sometimes to have converted them into chert, or a species of millstone (buhrstone) grit. These are the siliceous strata of Prof. Troost, so important under an economical point of view, from the quantity of iron which they contain. These beds are sometimes filled with encrinites and corals, mingled with a small number of shells, characteristic of the Carboniferous System. The psammites and the siliceous beds which we thus unite with the Carboniferous system, are of great thickness, and cover a considerable extent of country, so that the change which we propose will bring other important changes in a map of the United States, colored according to the European classification, such for example as that of Mr. Lyell.†

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* Mr. Hall, in his memoir upon the identity of the Western formations with those of New York, calls sub-carboniferous only the upper part of these psammites. (*a*)

(*a*) [I have not been so fortunate as to find fossils within two hundred feet above the black slates, although they are abundant at a greater elevation. The lower portion of these slates and sandstones in the vicinity of New Albany, Ia., have so great a resemblance to the rocks of the Portage and Chemung groups, that I could not forbear referring them to that period, while the more friable and micaceous sandstones above containing fossils of true carboniferous types, I called sub-carboniferous, from the fact that up to that time I was not aware that anything below the base of the great carboniferous limestone had been recognized as belonging to the carboniferous period.

It will be recollected that there is a thickness of more than five hundred feet between the top of the black slates and the base of the limestone.—(*Transactions of Am. Association of Geologists and Naturalists*, vol. i, p. 281.) This, if admitted to belong entirely to the Carboniferous system, is an immense addition to its thickness. On the other hand it must be recollected that this series holds the place of the Portage and Chemung groups, which can be clearly traced into Ohio, still holding a great thickness, and it seems scarcely possible that it can have entirely disappeared in so short a space, while a subsequent deposit has extended to Medina and Cuyahoga, in the eastern part of that state.

Were this the proper occasion, we might go on to show how the Chemung group of central and Western New York is more nearly related to the Carboniferous sandstones of the West than to the Hamilton group of Eastern New York.—J. H.]

† Our view has been adopted by Dr. Dale Owen, who has written to us, that since our travels in these countries he has had an opportunity to verify the truth of it in Kentucky, where he has recognized that in fact all the beds above the black slates belong to the Carboniferous system. This slate furnishes then a very constant horizon to distinguish the Carboniferous system from the lower deposits. (*b*)

(*b*) [We have no disposition to find fault with the reasoning of M. de Verneuil, or with the facts which he brings to sustain his views, but a careful study of the preceding pages clearly proves that no one point is yet established, and that the line of separation between the carboniferous and lower deposits is far from being

In Europe this stage is probably represented by the yellow sandstones of Ireland, and by slates and sandstones which we have seen in Westphalia, north of Hagen, and which have been described by Messrs. Sedgwick and Murchison. (Geol. Trans., vol. v.)

Above the psammites, or the siliceous strata, comes the carboniferous limestone, which is exactly the equivalent of that of Europe, and which contains its most characteristic fossils.

The third stage of the Carboniferous system is formed by the sandstones and coal shales which surmount the preceding limestone. Aside from their extent and their unexampled thickness, they appear to be the representative of the coal deposits of Europe. They contain, in fact, nearly the same plants, but they are distinguished, nevertheless, by their marine origin, or at least by their alternation with limestones filled with marine fossils. These limestones, whose thickness is insignificant compared with that of the whole of the coal series, are of great importance in the theory of the formation of coal. Their fossils are nearly the same as those of the carboniferous limestone.* The coal schists themselves contain very few fossil shells. Nevertheless, near Blossburgh, in Pennsylvania, and in Maryland, are found certain species analogous to those of the environs of Glasgow, in Scotland, such as *Euomphalus carbonarius*, *Bellerophon Urii*, *Machrocheilus curvilineus*, *Allorisma sulcata*, and some very rare bivalves resembling the Uniones.

Let us now pass in review the list of species common to the two continents, and rapidly indicate the parallel modifications which they present. According to our own observation, this list is composed as follows. *Phillipsia seminifera*, *Orthoceratites calamus*, *Goniatites rotatorius*, *Nautilus tuberculatus*, *Bellerophon*

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well defined. All our attempts to limit *systems*, where the whole is *one* great system, must fail in their application, and the facts in this case prove conclusively, that the line of separation between Carboniferous and Devonian is not yet so well defined as that between Devonian and Silurian, or even between the lower and upper divisions of the latter system.—J. H.]

* [We would ask, what is understood here by nearly the same? (à peu près les mèmes.) The fossils of these intercalated beds of limestone are generically identical with those of the great carboniferous limestone, but are they specifically identical or absolutely different? Have the *Spirifer attenuatus*, and *Terebratula Royisii*, and some others known in these thin beds of limestone in Ohio, ever been seen in the great carboniferous limestone below? For ourselves we are obliged to confess, that we have never had the good fortune to see them in the latter position in all the localities we have visited. We cannot, moreover, for other reasons, feel willing to admit that the same fauna which flourished during the deposition of the great carboniferous limestone, reappeared at intervals after the commencement of the deposition of the coal shales and sandstones, with plants indicating the existence of dry land and fresh water. All the species we have collected from these intercalated beds of limestone in the coal measures of Ohio, though of marine origin, are specifically distinct from any we have seen from the limestone below.—J. H.]

hiulcus, B. Urii, Euomphalus carbonarius, E. pentangulatus, Macrocheilus curvilineus, Allorisma sulcata, Terebratula Roissyi, T. planosulcata, Spirifer lineatus, S. striatus, S. attenuatus, S. cuspidatus, Orthis crenistria, O. resupinata, O. Michelini, Leptæna depressa, Chonetes sarcinulata, Productus semireticulatus, P. Cora, P. Flemingi, P. punctatus, P. costatus, Cidarites Nerii, Amplexus spinosus, Cyathophyllum mitratum, Chætetes capillaris, Fusulina cylindrica; total, thirty-one.

All these species, except the *Leptæna depressa*, and the *Orthis crenistria*, are peculiar to the Carboniferous system, and characterize it over a great part of the globe; for by a remarkable exception, many species of this system have at the same time circumscribed vertical limits and very extensive horizontal distribution: such are for example the *Productus semireticulatus*, *P. Cora*, and *P. Flemingi*, which have been found from the Altai and the Russo-Chinese frontiers to Missouri, and even upon the plateau of the Andes of Bolivia.

When we compare the carboniferous fauna of America with that of Europe, we see with astonishment, that notwithstanding the distance which separates these countries, the genera and the species present the same modifications, the same differences from the preceding fauna.*

In fact, while the persevering researches of Mr. King, in Pennsylvania,† go to prove to us the existence of large air-breathing animals at this epoch, the discovery of a Saurian recently made in the carboniferous beds in Germany,‡ proves that the appearance of this class of animals, more ancient than has been believed until now, was contemporaneous on the two continents.

The trilobites follow a similar order of decrease, and are reduced in America as in Europe, to some small species of the genus Phillipsia. The Goniatites offer also for the first time the new

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* The analogy between the two continents appears to be more marked at this epoch than at the anterior epochs, the number of identical species being relatively more considerable. If we seek the cause of this, we are led to attribute it to more analogous physical conditions, which proves the uniformity of the deposits of this epoch, and perhaps also to a peculiar disposition of the submarine outline, that is to say, the bottom and the islands which extended from Europe towards America. M. Elie de Beaumont explains this disposition in a very natural manner. He regards it as an effect of the W.N.W. upheaving which preceded the establishment of the Carboniferous system, and which he has called the system du Ballon of the Alsace. We are happy to see the beautiful theory of our illustrious friend thus confirmed by independent researches.

† See the interesting letter of Mr. Lyell upon the evidence of the footprints of a quadruped resembling the Cheirotherium, in the Carboniferous strata of Pennsylvania. (This Journal, ii ser., vol. ii, p. 25.)

‡ This discovery, of which we have been informed by von Buch, destroys the principal objection which could be made to the extent which we have given to the Palæozoic formation, in our work on Russia, by comprising in it the Permian System; for this objection was founded on the opinion then established, that the Saurians appeared for the first time in this system; and the importance of the appearance of animals of this class to determine the point of departure of the secondary formation.

type when the dorsal lobe, instead of being simple, is divided by a small medial saddle.

The distribution of the Productus, offers another remarkable coincidence. Unknown in America in the Silurian system, appearing under one or two small forms in the Devonian epoch, the species assume in the carboniferous rocks a development altogether in harmony with the facts observed in Europe. The Spirifers of this epoch present also in America the character of having the plications often dichotomous, which M. d'Archiac has already indicated in Europe,* and by which they are distinguished from those of the Devonian epoch, which have them always simple.†

As to the Terebratulæ, we will mention the interesting fact of the simultaneous disappearance of two species, the *T. reticularis* and *T. aspera*, which, during the Devonian and upper Silurian epochs, were spread with great profusion from the Altai and Ural to the Missouri. We will cite also, as simultaneous phenomena upon the two continents, the appearance of those Crinoids forming a passage to the echinoderms, such as the *Palæchinus* or *Melonites*, the extinction of those great corals, such as the *Favosites Gothlandica*, *Porites interstincta*, &c., and their replacement by the *Chætetes* and *Lithostrotion*, nearly identical in Europe and in America. The analogy between the two continents continues even to the Foraminifera and the plants. We have seen indeed that the *Fusulina cylindrica*, so characteristic of the carboniferous limestone of Russia, occurs in the cherts or siliceous beds of the coal sandstones of Ohio. And as to plants, the immense quantity of terrestrial species identical on the two sides of the Atlantic, proves that the coal was formed in the neighborhood of lands already emerged, and placed in similar physical conditions.

With the Carboniferous system terminates the palæozoic formation in North America. During all the time of its deposition, the surface was free from great disturbances.‡ Slow and insensible oscillations had caused to emerge areas more or less circular of the submarine surface where the Silurian and Devonian deposits were made, and had contracted the limits of carboniferous deposits; but the horizontality of the beds was not disturbed. It is only after the carboniferous epoch that an energetic force,

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* Memoir on the Palæoz. Foss. (Trans. Geol., vol. v, page 319.) See also Geology of Russia in Europe, vol. ii, p. 126. Von Buch, in his interesting memoir which he has published upon Cherry Island (*Bären insel*), has insisted with reason, on the importance of this character which might be thought insignificant.

† It is also only at the Devonian epoch that we find the Spirifers in which the back is divided by a slight furrow, as in *S. mucronatus* and *Bouchoidi*.

‡ In the eastern part of the United States, where the palæozoic formation is much disturbed and metamorphosed, Mr. H. D. Rogers believes he is able to recognize traces of dislocations, which have broken up the strata after the epoch of the Hudson River or Clinton Group. (This Journal, ii ser., vol. i, p. 411.)

folding and raising the terrestrial crust, gave birth to the chain of the Alleghanies. The manner in which the plications, largely undulated at first, contract, multiply and fold over in going from northwest to southeast, towards the metamorphic and granitic rocks, situated most frequently beyond the chain, properly so called, has been perfectly elucidated by the two Professors Rogers.*

It does not enter into our design further to extend this notice; having fulfilled, according to our ability, the end which we proposed, to establish a parallel between the palæozoic formations of North America and Europe. Permit us, in conclusion, to present a resumé of the course we have followed, and the principal results at which we have arrived.

In order to make fully understood the interest and importance of this parallelism, and the light which it throws upon the knowledge of palæozoic deposits in general, we have shown the advantageous geological conditions of North America, and how, owing to the horizontality of the beds over great extent of surface, to their concordant and uninterrupted superposition, it is possible to arrive at an absolute certainty as to the duration of species, that is to say, the point in the series where they first appear and where they become extinct.

In order to compare North America with Europe, it has been necessary for us to give a rapid glance at the groups and stages of which the palæozoic formation is there composed. The differences which are presented to us in the geognostic conditions of the state of New York and the Western States, such as Ohio and Indiana, have revealed to us the degree of importance which it is necessary to attach to these different groups. We have seen that their number, variable according to their vicinity or distance from lands emerged at the epoch of their formation, had little importance as regards the establishment of systems founded upon palæontological characters. We have seen also, that in general, the limestones are more constant than the shaly or arenaceous beds, that they form more extensive horizons, and furnish a surer guide to the geologist.†

Passing afterwards to a comparison of the two continents, we have shown, supporting our views by geological analysis, how the American substages should be grouped to correspond with the Silurian, Devonian and Carboniferous systems of Europe. We have not disguised the fact that the divisions introduced upon

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* On the Physical Structure of the Appalachian Chain as exemplifying the laws which have regulated the elevation of great mountain chains generally, by W. B. and H. D. Rogers.

† M. C. Prevost, in his memoir upon the synchronism of formations, (Comptes Rendus, April, 1845.) has clearly shown the importance of the pelagic calcareous deposits as compared with the arenaceous beds formed under the influences of coasts.

this principle did not correspond, in certain countries, with the divisions indicated by the mineralogical character of the rocks; thus the limit between the two stages of the Silurian system, very well marked in the state of New York, is observed near the Mississippi in consequence of the predominance of magnesian limestone; it is the same with the Silurian and Devonian systems, the limit between which is found in the upper part of the great calcareous formation called cliff limestone; as well also as with the Carboniferous system, in parts of the state of Ohio, where it is in contact with the Devonian psammites of Portage.

These mineralogical transitions, which one would expect in a country free from disturbances, would not, however, obscure the proofs of a parallel development of the animal kingdom in the two continents; for if, leaving aside the difficulties of fixing the limits between the systems, we compare the systems together, or still better, one by one the groups of which they are composed, we acquire the conviction that identical species have lived at the same epoch in America and in Europe, that they have had nearly the same duration, and that they succeeded each other in the same order. We have endeavored to prove that the first traces of organic life in countries the most remote, appear under forms nearly alike, at the base of the Silurian system; and that the same types, often the same species, are successively and in parallel order, developed throughout the entire series of the palæozoic beds. If we have not succeeded in lifting the veil which still hides from us the cause of this grand phenomenon, perhaps at least our observations demonstrate the insufficiency of those causes by which certain authors seek to explain it. They prove in effect that the phenomenon itself is independent of the influences which the depths of seas* exercise upon the distribution of animals: for if, in certain countries, the Silurian deposits prove a deep sea, they have on the contrary in the state of New York, a littoral character. They prove in fine, that in its general character it is equally independent of the upheavings which have affected the surface of the globe; for from the eastern frontier of Russia even to Missouri, distant from or near the lines of dislocation, in the horizontal beds as well as in those which are disturbed, the law according to which it is accomplished appears to be uniform.

(To be continued.)

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* We do not pretend to say that the differences of depth in the seas had not already an influence upon the distribution of animals; it is to this circumstance, on the contrary, that we attribute the more or less local fauna which we often discover in the palæozoic formation. But these local faunæ always afford some species which connect them with the epoch to which they belong. They are the exceptions (*hors d'œuvre*) which do not derange the general symmetry.

ART. V.—*The Dodo and its Kindred, or the History, Affinities and Osteology of the Dodo, Solitaire and other extinct Birds of the Islands Mauritius, Rodriguez, and Bourbon;* by H. E. STRICKLAND, and A. G. MELVILLE.*

THIS beautiful volume is illustrated by fifteen quarto and folded plates, containing one hundred and fifty figures chiefly lithographs; some are executed by the anastatic process—and three by a new process called Papyrography.

Part I. of this work, containing seventy pages, was written by Mr. Strickland, and comprises the historical and descriptive portions; Part II. (pp. 56) is by Dr. Melville, and includes the Osteology.

This is a very remarkable Book. The historical facts have been gathered with great industry from nearly one hundred and fifty works cited, and most of them consulted by the author, and they have been combined with signal skill and acuteness.

The singular birds of which the volume treats, peopled in great numbers the Islands Mauritius, Bourbon and Rodriguez, until nearly two centuries since, when they were exterminated by the hand of man. Their extinction is therefore not to be ascribed, like that of many races, to the agency of geological causes. Man, especially in the earlier colonial and savage state, indulges in the slaughter of the inferior animals—too often from the mere pleasure of destroying them even when their bodies are not subservient to his wants.

Mr. Strickland remarks, however, in the introduction—that "it appears highly probable that death is a law of nature in the species as well as in the individual; but this internal tendency to extinction is in both cases liable to be anticipated by violent or accidental causes. The object of the treatise is to exhibit some remarkable examples of the extinction, through human agency, and under circumstances of peculiar interest, of several ornithic species, constituting an entire sub-family." Mr. Strickland observes that the geographical distribution of organic groups is equally remarkable with their geological succession in time; certain groups of both animals and plants, often containing numerous genera and species, being found to be confined to certain continents and their circumjacent islands.

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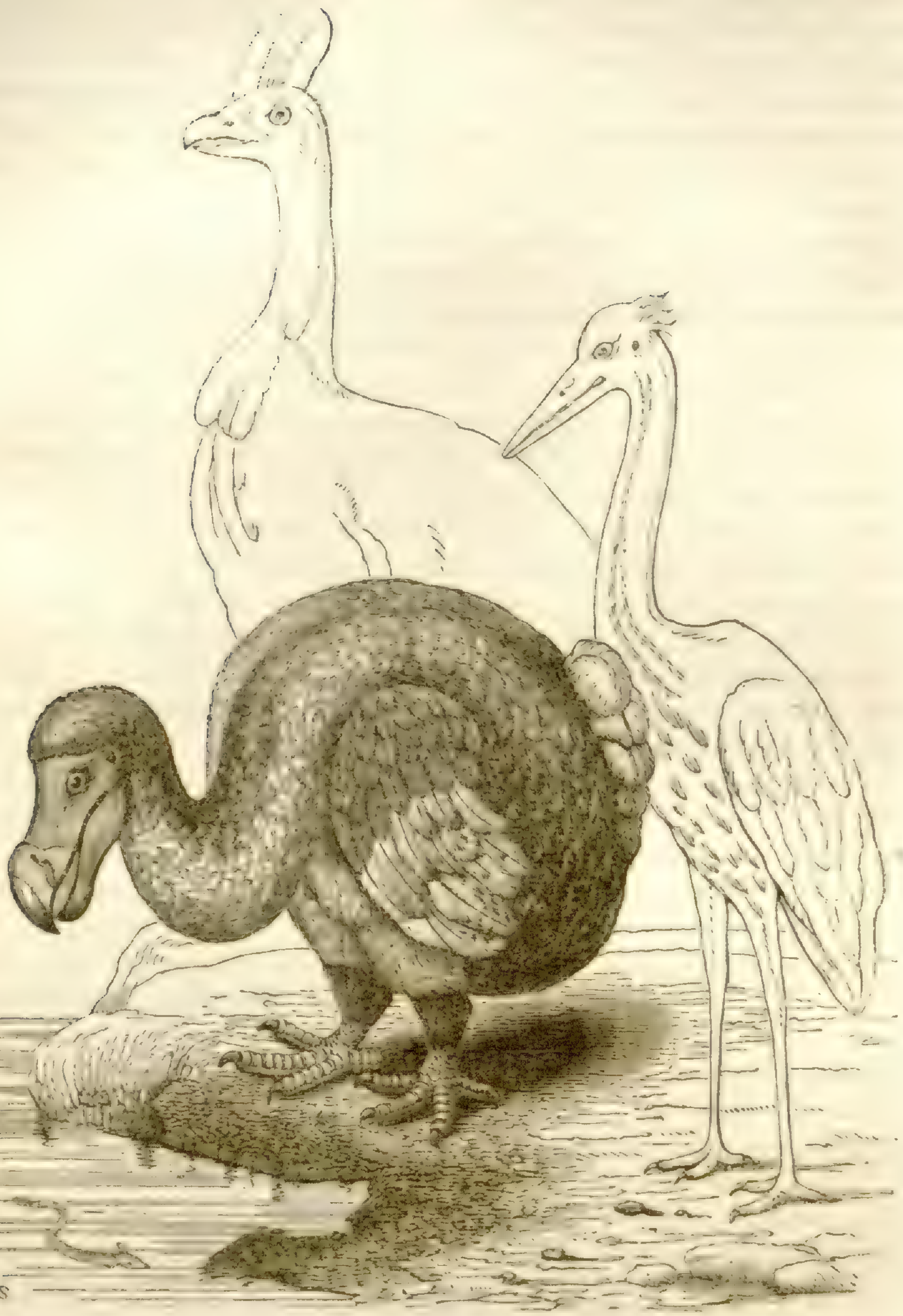
* The Dodo and its kindred, or the history, affinities and Osteology of the Dodo, Solitaire and other extinct birds of the Islands Mauritius, Rodriguez, and Bourbon. By H. E. STRICKLAND, M.A., F.G.S., F.R.G.S., *President of the Ashmolean Society*, &c., and A. G. MELVILLE, M.D., Edin., M.R.C.S., "PES et CAPUT uni reddentur formæ." London: Reeve, Benham and Reeve, 8 King William street, Strand. 1848. Quarto, pp. 141. Dedicated to P. B. Duncan, Esq., M.A., Keeper of the Ashmolean Museum.



The Dodo, with the Solitaire in the background.—Fac-simile of Roland Savery's picture of the Dodo, dated 1628, now in the Bellvedere at Vienna.

Detached islets, like the Galapagos, for instance, are often inhabited by terrestrial forms allied to those of the nearest continent although hundreds of miles distant, and evidently never connected with them; analogous beings having been introduced without making a violent break in the system of nature. The three small volcanic islands whose ancient birds form the subject of the present volume, although placed at considerable distances apart, are still nearer to each other than to any contiguous land. They lie in the Indian Ocean east of Madagascar. A few of their indigenous plants and animals are either allied to, or identical with, the products of Africa;—the larger number resemble those of Madagascar; while certain species are confined to the islands themselves, especially a peculiar group of birds, specifically distinct in each island, yet allied in their general characters, and remarkably isolated from any known forms in the world. "These birds were of large size and grotesque proportions, the wings too short and feeble for flight, the plumage loose and decomposed and the general aspect suggestive of gigantic immaturity." "The civil history of these birds, if we may so speak, is as remarkable as their organization. About two centuries ago, their native isles were first colonized by man, by whom these strange creatures were speedily exterminated"—and "so rapidly, that the vague descriptions of early navigators were long regarded as fabulous or greatly exaggerated, and these birds, almost cotemporary with our great grandfathers, became associated in the minds of many persons with the Griffin and the Phœnix of mythological antiquity." "The object of the present work is to vindicate the honesty of the rude voyagers of the seventeenth century—to concentrate the evidence—to describe the few remains—to excite farther inquiry, and fix the rank of these birds in the system of nature."

These birds technically called the *Didinæ*, "furnish the first clearly attested instance of the extinction of an organic species through human agency, although other instances have occurred both before and since,* and many species of animals and plants are now dying away under the advance of human population."

In the case of the Didinæ our only sources of information are the rude narratives of unscientific voyagers, a few oil paintings and a few scattered osseous fragments, which have survived the

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* For example, the Irish Elk—*Cervus megaceros*, and the *Bos primigenius*, or Urus, destroyed in ancient, and the Dugong in modern times. The Aurochs or *Bison priscus* is even now preserved only by imperial protection in the Bialowiksa forest in Russia, and the Czar Nicholas has lately presented a living pair to the Zoological Gardens of London. The *Nestor productus*—a parrot of Phillip's Island near Norfolk Island, is now extinct; and the few surviving individuals confined in cages refuse to breed. There is also a burrowing parrot, *Strigops habroptilus*, from New Zealand, and there are still surviving two or perhaps three species of *Apteryx*.

neglect of two hundred years. In many cases there exist better data for determining a species which perished ages ago by geological causes, than in the case of a group of birds, several species of which were living in the reign of Charles the first of England.

Historical notices of the Dodo.—This strange abnormal bird, according to undoubted evidence, formerly existed in great numbers in the Isle of Mauritius. The evidence is *historical*, *pictorial* and *real*.

Although it is asserted that Mauritius was discovered early in the sixteenth century, nothing definite was known of it until the close of that century, when the Dutch navigator Van Neck took possession of it, as it was uninhabited, and called it Mauritius.

The author has copied a quaint old print of Van Neck, exhibiting the ship's company reveling in the virgin profusion of the island. Birds, fishes, fruits, tortoises, bats and paroquets, among animals, and Dates and other Palm trees among plants, with the men at their labors, are all exhibited in a grotesque form, animated and graphic, but with wild violations of proportion and perspective.

Clusius, a Dutch writer—1605—gives a figure of the Dodo, and states that stones an inch in length were found in the gizzards of this bird, which were as large as in the swan but very different in form.

In 1602, Admiral Schuurmans staid some time at Mauritius, and frequently mentions the Dod-aarsen or Dodos, on which the seamen reveled—three or four of these birds, and in one instance two, weighing probably fifty pounds each, having furnished an abundant meal for a ship's crew. They are described as having great heads with hoods thereon, with round sterns, without wings or tail, and with only winglets on their sides and four or five feathers behind; and as carrying commonly in the stomach a stone the size of a fist. The sailors sometimes caught fifty birds in a day, half of which were Dodos. Their historian has recorded their doings in homely verse, which is thus "Englished" by our author.

> "For food the seamen hunt the flesh of feathered fowl,
> They tap the Palms, the round sterned Dodos they destroy,
> The Parrot's life they spare that he may scream and howl
> And thus his fellows to imprisonment decoy."

In 1605, Clusius saw at Leyden a Dodo's leg; the tarsus over four inches long and nearly four in circumference, covered with thick yellowish scales. The toes were about two inches and the nails about one inch long.

The birds are mentioned again at Mauritius in 1606 by Cornelius Matelief, a Dutch admiral, and in 1607 the crews of Van der Hagen feasted on *Dodars* and other game, and they salted Dodars and tortoises for consumption on the voyage.

In 1607, the crews of Van der Hagen's two ships "feasted on abundance of tortoises, dodars, pigeons, turtles, grey parroquets and other game," which they caught by hand in the woods, and they salted quantities of *dodars* and tortoises for their voyage.

In 1611, P. W. Verhuffen touched at Mauritius, and mentions *Dodos* under the name of *Totersten*. He describes them as Van Neck had done;—says that his sailors killed numbers of them daily for food, and that the Dodos sometimes inflicted severe wounds upon their aggressors with their powerful beaks.

In 1617, Picter Van den Broecke visited Mauritius, and in the account of his voyages there is a rude figure of the Dodo and also of a short winged bird resembling the Apteryx, but neither of the figures is alluded to in the book.

Sir Thomas Herbert was at Mauritius in 1627, and has given a figure of the Dodo and a description, of which the language was varied in other successive editions. All these descriptions are amusing on account of their quaintness; the following is the most recent; "The Dodo: a bird the Dutch call Walghvogel or Dod Eersen; her body is round and flat, which occasions the slow pace, or that her corpulencie; and so great that few of them weigh less than fifty pounds; meat it is with some, but better to the eye than stomach; such as only a strong appetite can vanquish; but otherwise, through its oyliness it cannot chuse but quickly cloy and nauseate the stomach, being indeed more pleasurable to look than feed upon. It is of a melancholy visage as sensible of natures injury in framing so massie a body, to be directed by complementary wings, such indeed as are unable to hoise her from the ground, serving only to rank her amongst birds; her head is variously drest, for one half is hooded with down of a dark color; the other half naked and of a white hue, as if lawn were drawn over it; her bill hooks and bends downwards; the thrill or breathing place is in the midst; from which part to the end, the color is of a light green mixt with a pale yellow; her eyes are round and bright (her eyes are small, and like to diamonds round and rowling);* and instead of feathers has a most fine down; her train (like to a *Chyna* beard) is no more than three or four short feathers; her legs are thick and black; her tallons great; her stomach fiery, so as she can easily digest stones (stones and iron); in that and shape not a little resembling the Ostrich."

François Cauche says, that in 1638, he saw in Mauritius birds "larger than a swan, covered with a black down, with curled feathers on the rump, and similar ones in place of wings; that the beak was large and curved, the legs scaly, the nest made of herbs heaped together, that they lay but one egg of the size of

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* The clauses here in parentheses are from one of the other descriptions of the same author.

a half penny roll or of that of a Pelican, and that the young ones have a stone in the gizzard."

Sir Hamon Lestrange, father of the more celebrated Sir Roger, relates, thus: "About 1638, as I walked London streets, I saw the picture of a strange fowle hung out upon a cloth, and myselfe with one or two more then in company went in to see it. It was kept in a chamber, and was a great fowle, somewhat bigger than the largest Turky Cock, and so legged and footed, but stouter and thicker and of a more erect shape, colored before like the breast of a young Fesan, and on the back of dun or deare color. The keeper called it a Dodo, and in the end of a chymney in the chamber there lay a heape of large pebble stones, whereof hee gave it many in our sight, some as bigg as nutmegs, and the keeper told us shee eats them, (conducing to digestion,) and though I remember not how farr the keeper was questioned therein, yet I am confident that afterwards shee cast them all againe."

Thus it appears that a living Dodo was exhibited in London, more that two hundred years ago.

In Piso's edition of Bontius, 1658, there is a description of the Dodo, with a figure, being the earliest copy from one of Savery's paintings. The bird is described as between the ostrich and turkey. Its legs are short, with four toes, stout, long, scaly, and the claws strong and black—the head large and clumsy, and covered with a membrane like a hood. The eyes are large and black; the neck curved, prominent and fat; the beak remarkably long and strong—the gape hideous—enormously wide, as though formed for gluttony. The body is fat, round and clothed with grey feathers, in the manner of ostriches; in place of quills are small grey feathered wings, and in place of a tail, fine curved plumes of the same color. The bird is slow and stupid, and easily taken by the hunters. The flesh, especially that of the breast, is fat and eatable, unless when it is old or not well boiled. Three or four have sometimes sufficed to feed a hundred seamen. They swallow pebbles and all sorts of hard substances without digesting them.

Captain Wm. Talbot, of the ship Berkley Castle, was in Mauritius in 1679, and the journal of his mate, Benjn. Harry, mentions, among the productions of the island, *Dodos, whose flesh is very hard.* This is the most recent account of the existence of Dodos in Mauritius.

The above is a condensed abstract from Mr. Strickland's work, of the historical evidence regarding the existence of the Dodo. In 1644, the Dutch began to colonize Mauritius, and these noble birds were so speedily destroyed by the thoughtless rapacity of the colonists—aided by their companions, dogs, cats and mice, which eagerly devoured the eggs of the Dodo—that they are not even mentioned by Leguat among the productions of the island.

After the French took possession of the country, in 1712, under the name of the Isle of France, we hear no more of the Dodo among living beings.

Specimens and remains of the Dodo.—In Tradescant's catalogue of his museum, in South Lambeth, near London, there is this entry:

"Dodar from the island of Mauritius; it is not able to flie, being so big."

This was an entire bird; it was probably the same that was seen alive by Lestrange, in 1638; it was seen entire by Willughby, whose Ornithologia was published in 1676, and the specimen is alluded to by others. It passed with the rest of Tradescant's collections into the Ashmolean Museum, at Oxford, where the head and foot are still remaining. These belonged to a stuffed specimen of Tradescant, which was bequeathed with the rest of his curiosities to Elias Ashmole, the munificent founder of the Ashmolean Museum, at Oxford. There it remained entire for a century, until 1755, when the vice-chancellor and the other trustees, came in an unlucky hour to make their annual visit to the museum. Zoology had then no legal existence as a science taught in the University; the specimen of the Dodo had become decayed by time and neglect, and was ordered by the visitors to be removed. On this fatal decree Mr. Lyell remarks: "Some have complained that inscriptions on tomb-stones convey no general information, except that individuals were born and died—accidents which happen alike to all men. But the death of a species is so remarkable an event in natural history, that it deserves commemoration; and it is with no small interest that we learn from the archives of the University of Oxford, the exact day and year when the remains of the last specimen of the Dodo, which had been permitted to rot in the Ashmolean Museum, were cast away. The relics, we are told, were "a Museo subducta, annuentibus Vice-cancellario aliisque Curatoribus, ad ea lustranda convocatis—die Januarii 8vo, A. D. 1755."

By a lucky accident, the head and one of the feet of the last descendant of an ancient race escaped destruction from the flames, and are still in the Ashmolean Museum. The head is in tolerable preservation, with the peculiar beak and nostrils, the bare skin of the face, and the partially feathered occiput, formerly compared to a hood. The eyes still remain dried within the sockets, but the corneous extremity of the beak has perished; the specimen was probably a female. This head has been of late carefully dissected down on one side so as to expose its osteological structure.

A leg, or rather foot, of the Dodo, belonging to a larger individual than that mentioned above, is still preserved in good con-

dition in the British Museum; it exhibits the external characters of the tarsus and the toes in a very interesting manner.

A cranium, mentioned by Olearius as being in 1666 in the Gottorf Museum, at Copenhagen, after being neglected for almost two centuries, was lately "recovered by Prof. C. Reinhardt from a heap of venerable rubbish." It corresponds very nearly with the Oxford specimen, but all the soft parts are removed.

These are all the known genuine fragments of the Dodo, but it is hoped that others may be yet discovered in the island of Mauritius, by researches about to be undertaken there.

Pictures of the Dodo.—In addition to the rude drawings of the early voyagers, all of which, with a single exception, are marked by strong verisimilitude, there are five oil paintings by eminent artists, which leave no reasonable doubt of their being faithful copies of the originals. One of the paintings is anonymous—three are by Roland Savery, an eminent Dutch painter of animals, early in the 17th century, and one is by his nephew, John Savery. The first of these paintings is that copied in all books of natural history. It was painted in Holland, from the living bird brought from Mauritius. This picture, once the property of Sir H. Sloane, and afterwards of the artist Edwards, was by him deposited in the British Museum, where it is now in the bird gallery, along with the Dodo's foot. It is believed to have been painted by one of the Saverys, and to have represented a larger bird than that to which the foot belonged. At the Hague there is a painting by Roland Savery; the subject is Orpheus charming the animals by his music: innumerable beasts and birds are depicted with perfect accuracy, and among them, in one corner, the clumsy Dodo spell-bound, and although on a small scale, perfectly exact, even in the minutest particulars. The Dodo and all the other animals were evidently copied from living specimens.

At Berlin, Mr. Strickland found, in 1845, among several highly finished pictures by Roland Savery, one dated 1626, representing numerous animals in Paradise, one of which is a Dodo, which may have been painted from the living bird, brought home by the Dutch navigator, Van Neck.

There is also a picture of the Dodo, by Roland Savery, forming part of a larger picture, at Vienna; it is dated 1628. "There are two circumstances which give an especial interest to this painting, [see plate, p. 53.] First, the novelty of attitude in the Dodo, exhibiting an activity of character which corroborates the supposition that the artist had a living model before him, and contrasting strongly with the aspect of passive stolidity in the other pictures; and secondly, the Dodo is represented as watching an eel in the water." Are we hence to infer that the Dodo fed on eels, as the advocates of the raptorial affinities of the Dodo

would conclude? Our author, however, considers the eel as introduced for pictorial effect, believing and showing the Dodo to have been a frugivorous bird. In the British Museum, is still another picture of the Dodo, painted by John, nephew of Roland Savery, in 1651. It is a fac-simile of the pictures already mentioned; but it is exaggerated to nearly double of the size allotted to the Dodo; it stands 3 feet 6 inches high.

Conclusions respecting the Dodo.—"We must figure to ourselves,"—remarks our author,—"a massive, clumsy bird, ungraceful in form, and with a slow waddling motion," as a duck or gosling would appear if magnified to the size of a swan. Examples are not wanting in zoology, in which certain species or certain organs remain permanently imperfect, or only partially developed. The Greenland whale has only incipient teeth, that never penetrate the gums—as the mode of life of this animal and the nature of his food do not require mastication; the Proteus, living in subterranean caverns, retains the gills and the tail, which are dropped in the case of other Batrachians, and the eyes remain mere subcutaneous specks, without vision. So the Dodo remains a permanent nestling, as the Proteus is a permanent tadpole; it (the Dodo) is clothed with down instead of feathers, and the wings and tail are too short to admit of flight. The fishes and crustacea of the Mammoth cave of Kentucky, are eyeless, because in the dark cavern which they inhabit they have no occasion for eyes. Similar reasons might doubtless be suggested in other cases—but aside from such reasons, our author remarks, that the Creator appears to have assigned to each class of animals a definite type or structure, from which he has never departed; thus, if teeth are appropriate to a mammal, eyes to a vertebrate, and wings to a bird, we may understand why in a whale, the Proteus and the Dodo, these organs are only rudimentary—only suppressed, not annihilated.

We should be slow to impute imperfection to any of the works of the Creator; a definite structure is given to every animal, adapted to the conditions of its existence; "in this view every department of the creation is equally perfect—the humblest animalcule or the simplest Conferva being as completely organized with reference to its appropriate habitat, and its destined functions, as man himself. Such a view of creation is surely more philosophical than the crude and profane ideas entertained by Buffon and his disciples, one of whom calls the Dodo—'un oiseau bizarre dont toutes les parties portaient le caractère d'une conception manquée.' He fancies that this imperfection was the result of the youthful impatience of the newly formed volcanic islands which gave birth to the Dodo, and implies that a steady old continent would have produced a much better article."

To what class of birds does the Dodo belong?—Our limits will not permit a discussion of the various opinions which have been entertained by eminent naturalists. The Dodo has been reckoned a Gallinaceous bird—by others as a modified form of the Raptores, or birds of prey; some have endeavored to trace its analogies with the Penguins, others with the Ostrich, &c.

Mr. Strickland thus sums up the arguments that go to sustain the opinion first advanced by Prof. Reinhardt, of Copenhagen, and fully sustained by our author, which refers the Dodo to the Columbidæ, or pigeons.

"If now we regard the Dodo as an extreme modification not of the vultures, but of these vulture-like frugivorous pigeons, we shall, I think, class it in a group whose characters are far more consistent with what we know of its structure and habits. There is no a priori reason why a pigeon should not be so modified, in conformity with external circumstances, as to be incapable of flight, just as we see a grallatorial bird modified into an ostrich, and a diver into a penguin. Now we are told that Mauritius, an island forty miles in length, and about one hundred miles from the nearest land, was, when discovered, clothed with dense forests of palms, and various other trees. A bird adapted to feed on the fruits produced by these forests, would in that equable climate have no occasion to migrate to distant lands; it would revel in the perpetual luxuriance of tropical vegetation, and would have but little need of locomotion. Why, then, should it have the means of flying? Such a bird might wander from tree to tree, tearing with its powerful beak the fruits that strewed the ground, and digesting their stony kernels with its powerful gizzard, enjoying tranquillity and abundance, until the arrival of man destroyed the balance of animal life, and put a period to its existence. Such in my opinion," adds Mr. Strickland, "was the Dodo, a colossal, brevipennate frugivorous PIGEON."

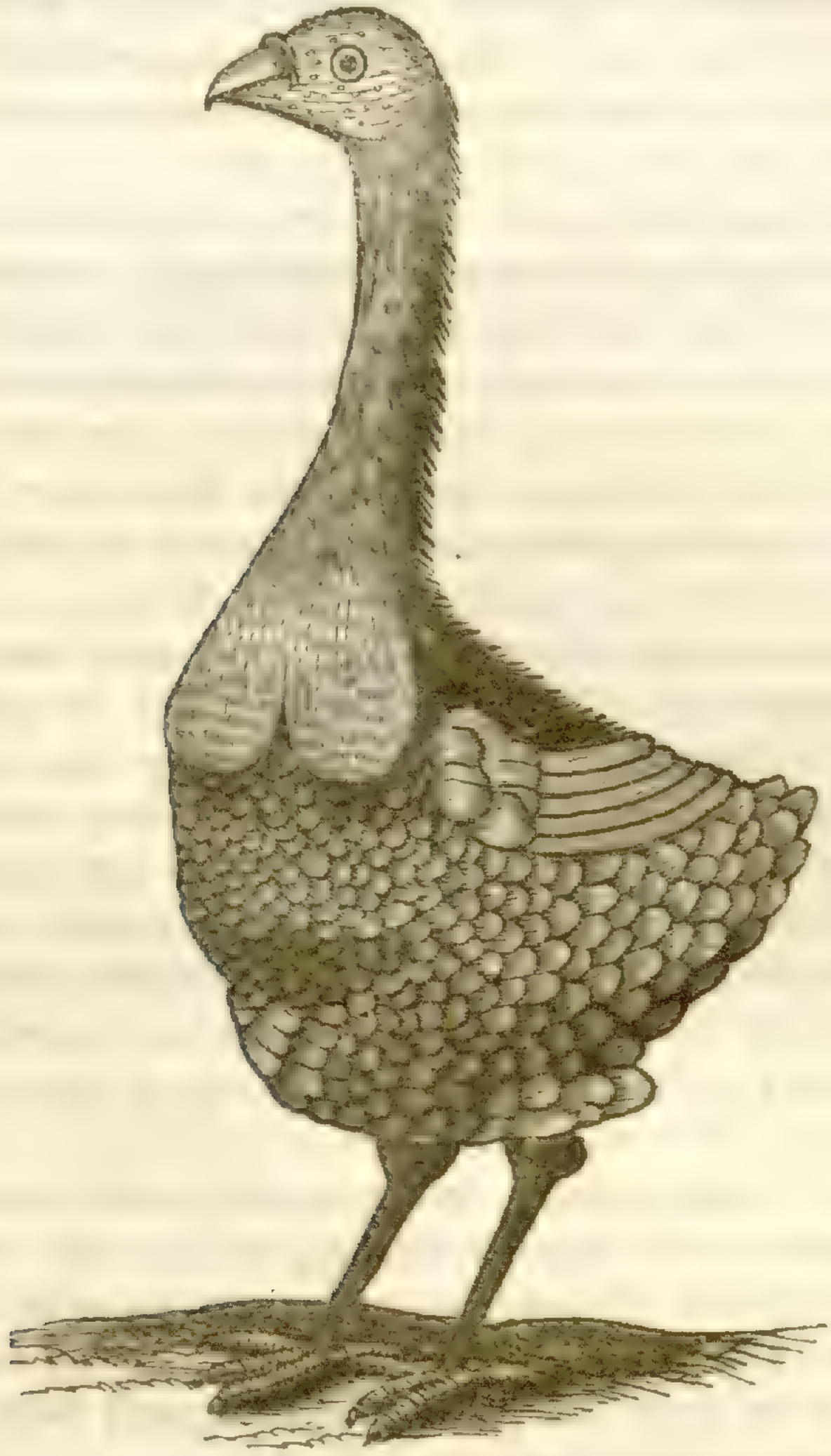
This opinion is sustained by many anatomical and other considerations which we are obliged to omit. We have endeavored to present a condensed abstract of the historical and descriptive facts, and we have copied one of the figures, that a more definite idea may be obtained of the appearance of this remarkable bird.

The Solitaire, the brevipennate bird of the Island of Rodriguez.

The Solitaire, (Pezohaps solitarius, *Str.* and *Mel.*, Didus solitarius, *Gmelin,*) was also a bird of remarkable structure, and the evidence of its existence, although less abundant than that of the Dodo, is equally decisive.

Rodriguez, an island fifteen miles long by six broad, lying three hundred miles east of the Mauritius, is distinguished as being its birth-place.

In 1691, a party of French Protestants led by François Leguat, settled upon this island, then uninhabited, and remained there two years. Leguat was an intelligent and educated man, and has left a very interesting account of their adventures and of the productions of the island.



THE SOLITAIRE.

The most interesting part of his work, for our present purpose, is that relating to *the Solitaire*. Although, remarks Leguat, they are numerous, they are generally seen alone, or only in pairs and very rarely in flocks. On the males the feathers are brown gray; feet and beak like those of a turkey but more crooked; stern round with very little tail, but covered with feathers. Neck straight, longer than a turkey's, with elevated head. They are taller than turkeys. Eyes black and lively, and the head without a comb or cop. Being almost wingless they cannot fly; they beat themselves with their wings, making a noise like a rattle, and audible 200 paces off; they flutter when they call one another. They whirl twenty or thirty times together in the same direction during four or five minutes. Its defense is its beak and a little round

ball of bone at the end of the wing. They are difficult to catch in the woods, but are easily run down in open places.

From March to September they are fat and delicate, especially when young. Some of the males weigh forty-five pounds.

The females are very beautiful, and are careful to adjust their feathers with great exactness: those on their thighs are round like shells, and being very thick have an agreeable effect. They walk with so much stateliness and grace as to excite a degree of admiration which often saves their lives.

"Though these birds will sometimes very familiarly come up near to one when we do not run after them, yet they will never grow tame. As soon as they are caught they shed tears without crying, and refuse all manner of sustenance till they die."

M. Leguat contends with easy credulity, that the stone always found in their gizzards was there when they were hatched, because, as he says, the passage from the craw to the gizzard is too small to admit a stone of half the size. He says it is flat on one side and round on the other, and so hard that they found them excellent whetstones. Their nests are made of palm leaves and are eighteen inches high. They lay only one egg, which is larger than that of a goose, and the incubation is shared both by the male and female during their term of seven weeks, during all which period and for several months while their young are unable to provide for themselves, they repel every bird of their own species to a distance of 200 yards, the male bird repelling the males, and the female the females—the male calling her for this purpose when away, by making a noise with his wings. After raising the young bird, the parents are generally seen together and remain associated. M. Leguat relates, with some doubt whether he shall be believed, that a companion is brought to the young Solitaire, by a company of thirty or forty birds, some days after it leaves the nest, and the parent birds march with the band to some bye place, where they are left alone.

From the figure given by Leguat, the Solitaire must have been a bird of noble mien—stately like the wild turkey, but taller than that bird.

The dates of the plantane, a sort of palm tree, were among their articles of food.

Rodriguez is inhabited by a few colonists under the authority of England, but they state that no such bird is known to them; and Edward Higgin, Esq., of Liverpool, who was shipwrecked and remained two months on this island, avers the same, while he bears full testimony to the general accuracy of Leguat's book.

Although we cannot look for any living specimens of the Solitaire, we may expect that their skeletons will be found in the caverns and diluvium of Rodriguez. The legs and neck were longer, the beak shorter, and the wings, although useless for

flight, somewhat more developed than in the Dodo. It is now rendered certain from osteological characters, that the Solitaire was allied to the Dodo and not to the ostrich.

The bones hitherto found are not of a very decisive character, but they indicate analogies with the Dodo—and "as far as we can trace the points of agreement between these two extinct birds, they are shared in common with the pigeons and exist *in no other known families of birds.*" P. V. Strickland, in further confirmation of his views, refers "to the feeding on dates or plantains, the monogamous habits, the laying of only one egg, and the inability of the nestling to provide for itself." The first of these characters is not found in birds of prey—nor the three last in gallinaceous birds, but the whole of them are consistent with the habits of that anomalous family, the *Columbiadæ*. The sternal keel of the Solitaire, and the strong muscles of the breast imply that its wing although too short for flight, was an arm of defense.

On the whole, there appears to be good evidence, that Rodriguez was once inhabited by a splendid family of birds of the Columbine family, but of a larger size than any which now walk the earth. They were the cotemporaries of the Dodos, that other colossal and clumsy family of the Mauritius, and both might have remained to this day, had not the destroying arm of man been raised against them, so that they have been, for two hundred years, exterminated.

Brevipennate birds in the Isle of Bourbon.

"This volcanic island lies about one hundred miles south of Mauritius, and was inhabited by two species of birds whose inability to fly, and their consequent rapid extinction, bring them into the same category with the Dodo of Mauritius and the Solitaire of Rodriguez."

Captain Castleton visited Bourbon in 1613, and found "store of land fowl, both small and great, plentie of Doves, great Parrats and such like; and a great fowl of the bigness of a Turkie, very fat and so short winged that they cannot flie, beeing white, and in a manner tame; and so are all other fowles, as having not been troubled nor feared with shot. Our men did beat them down with sticks and stones."

In 1682, Bontekoe, a Dutch voyager, found in Bourbon, geese, parrots, pigeons and other game, also Dod-eersen, which have but small wings, and so far from being able to fly, they were so fat that they could scarcely walk, and when they tried to run, they dragged their underside on the ground. This navigator appears to have confounded this bird with the Dodo.

Carré, a Frenchman, in 1668, saw in Bourbon the so-called *Oisseau Solitaire*—a lover of solitude and frequenting the most

secluded places. It resembles a turkey, but has longer legs. "The beauty of its plumage is delightful to behold. It is a changeable color, which verges upon yellow. The flesh is exquisite; two of these shipped for the king of France, soon died of melancholy, having refused to eat or drink." Not long after Carré's visit, M. de la Haye, with colonists from Madagascar, visited Bourbon, and a gentleman of his party confirms the above account, but gives proof of a second species of brevipennate birds having inhabited these islands.

"*Solitaires.*—They are of the size of a large goose—white and black on the tips of the wings and tail; the tail feathers resemble those of an ostrich; the neck is long and the beak like that of a woodcock, but larger; the legs and feet are like those of turkeys. This bird has recourse to running, as it flies very little.

"*Oisseaux bleus*, the size of *Solitaires*—plumage wholly blue—beak and feet red, resembling the plumage of a hen. They do not fly, but they run extremely fast, so that a dog can hardly overtake them; they are very good eating."

The following conclusions are drawn by Mr. Strickland.

1. That a brevipennate bird, distinct from the Dodo of Mauritius, and from the so-called Solitaire of Rodriguez, formerly inhabited the Isle of Bourbon, probably without powers of flight.

2. A second brevipennate bird, the *Oisseau bleu*, was a native of Bourbon—although from its speed in running it probably escaped the notice of the earlier voyagers.

3. One species at least of the apterous birds survived in Bourbon, till about the middle of the last century. From the first colonization of the island, the woods were filled with birds that were not alarmed at the approach of man; among these the Solitaire (erroneously called the Dodo) was pursued on foot.

4. In 1763, there were still in Bourbon some curious birds which never descended to the sea-side, and which were so tame as to suffer themselves to be killed by the stroke of a walking stick; what they were is not known.

5. A brevipennate bird inhabited Madagascar less than two centuries ago. Flacourt, 1658, relates that the *Vouron patra*, a large bird, frequented the S.E. of Madagascar; it lays eggs like an ostrich—lives in desert places, and cannot be captured.

The three islands, Mauritius, Rodriguez and Bourbon—a group whose members are indeed somewhat remote from each other—were inhabited until the time of human colonization, by at least *four* distinct but probably allied species of brevipennate birds. An analogous case has been made out in New Zealand;*

* By Cotton, Williams, Colenso, Mantell, and others, with the aid of Owen's consummate anatomical skill. A vast collection of bones has been recently obtained with much toil and no small danger, by Mr. Walter Mantell, and sent to his eminent father, Dr. Gideon A. Mantell, who places them at Mr. Owen's disposal.

from abundant osseous remains, two new genera of brevipennate birds have been reconstructed. Seven species of Dinornis and two of Palapteryx have been ascertained, and two surviving species of Apteryx, present almost expiring members of the same zoological group.

PART II. of this work.—*Osteology of the Dodo and Solitaire.*

After making so full an abstract and analysis of Part I, by Mr. Strickland, containing the historical and descriptive facts, we regret to dismiss Part II, evidently the result of laborious and learned industry, without citations or any attempt at condensation or analysis; for the reason which will be obvious to any one who will look through the fifty-six pages quarto, chiefly in fine type, consisting of details in comparative anatomy, too technical to admit of the slightest variation in language, and already compressed within the most narrow limits consistent with perspicuity. To the great masters in comparative anatomy, we must consign the duty of giving an opinion in a case in which no verdict on the author's labors can be accepted unless from a jury of his peers, of whom the number duly qualified cannot be great.

No intelligent person, however, can fail to appreciate the proofs every where presented, of great acuteness in comparing and precision in describing, the wide range of affinities which are the subjects of discussion. We observe also, that several eminent continental naturalists coincide, either entirely or mainly, in the opinions entertained by the authors of the volume before us.

It is a striking example of refined investigation—an elegant specimen of the elaborate manner in which research is often carried forward at the present day—and the costume of the work is in full keeping with its contents. The lithographic illustrations are beautiful, and the diagrams of the bones must, we should suppose, satisfy the most fastidious anatomist.

In closing our remarks, we feel almost as if we had been copying epitaphs, and musing among the graves of gone by generations. We have had before us the painful story of the utter extinction of large families of birds, exceeding in size and equalling in interest any that are now living upon the earth. The great destroyer, man, has waged war from the days of Nimrod, upon the animal creation, and he spares only a few races, which are made subservient to his will. The time will come when the wide ranging buffalo of America will be found no more among living animals, and naturalists will gather up his dispersed bones, and labor to reconstruct his original form. A large proportion of the beasts that now roam our forests, may hereafter be known only in the history of the past.

SEN. ED.

Art. VI.—*On Single and Double Vision produced by viewing objects with both eyes: and on an Optical Illusion with regard to the distance of objects;* by John Locke.

I had commenced the investigation of this subject so early as 1816, while I was a student of medicine in Yale College, and I have occasionally turned my attention to it up to the present time.

Although I have been fairly anticipated in the publication of some of my results, perhaps most of them, by the late investigations of Prof. Wheatstone,* and Sir David Brewster,† yet I deem it not useless to give you an account of the history of my own experiments and conclusions, especially as some of them are not, so far as I know, contained in the publications of either of the distinguished philosophers who have just written upon the subject. It is a well known phenomenon, that with both eyes open we can see a single object either single or double, according as the axes of the eyes are made to converge and meet either at the object, or at a point nearer than that object. Having acquired the power of voluntary convergence of the optical axes to an extreme degree without the aid of viewing near objects, such as the nose, or a finger held near to the eyes, I commenced my experiments as follows:

Experiment I.—I viewed a burning candle at the distance of about eight feet, the axes of the eyes being "crossed" or extremely converged. Two images were of course seen, the distance between which could be varied at pleasure by the amount of that convergence. The two images of the candle being thus seen, I suddenly closed one of my eyes, when the image on the *same side* of the closed eye vanished. Thus on closing the right eye, the right image disappeared, and on closing the left eye, the left image became extinct.

Inferences.—1st. As the axis of the right eye was directed to the left of the object and the image which disappeared on closing that eye was to the right of it, that image must have been an *oblique* one, seen as we see lateral objects to which the eyes are not directed. It appears too, that while the axes were converged upon vacancy, the oblique image in the right eye took the place of an image formed directly in the axis of the left eye, and the same relatively of the left eye; thus each eye *appeared to have* an image in its axis, which image was really in the opposite eye.‡

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* I have not seen his paper. † Phil. Mag., May, 1847.

‡ This is not always the condition of strabismus, for one eye may be so directed that the axis shall be on the object while the other is oblique.

2d. The two oblique images on the retina must have been formed on points nearer to the nose, or nearer to the medial line of the body than the principal axis of perfect vision.

3d. The images appeared in such position as objects should have been to produce pictures on the same parts of the retina, *the axes being at the same time parallel*, or nearly so.

4th. As with both eyes we see a lateral object ordinarily single, especially when at the same distance as the principal object viewed, it is inferred that the two pictures, one in each eye, must fall on parts of the retina not correspondent to the medial line of the body, in order to produce single vision. For example, on looking at a person standing ten yards in front, the image of a person standing two yards or more to the right will appear *single* though not well defined. The picture of this second person must in such case be formed to the left side of the retina of both eyes, *towards* the nose in the right eye, and *from* it in the left eye. In these two situations on the retina and in no other, will the two oblique pictures present a single image to the mind.

5th. All this establishes the principle that *certain parts of the retina of one eye* CORRESPOND *to certain specific parts of the retina of the other eye, in such a manner that when identical pictures fall on those corresponding parts, single vision is the result.* Those corresponding parts lie inward in one eye, and outward in the other, viz.: both to the right or both to the left. From each of those corresponding parts of the retina, it is probable that the fibres of the optic nerve proceed, and severally unite at the point of anatomical communication where the optic nerves cross, before entering the brain; hence the single impression or single image.

It may be added to this experiment (I), that if the finger be pushed against the under part of the eyeball so as to roll it upward, the image in that eye will appear to descend, and double vision will thus be the result. Here the eye being rolled upward, the image falls on the upper part of the retina; hence the impression of a lower object would form a picture on that part, *were the eye not distorted.**

Experiment II.—Two candles of equal size and height were placed side by side on the table, and, by converging the axes of the eyes, four images were produced. As the convergence progressed, each pair of images receded gradually from the original place of the single image until the two contiguous ones, the second and third, approached, and finally coalesced into one, when three images only were in view. The same experiment may be made with two letters or any other figures or objects which are equal in size and form, as follows:

* In all cases the mind seems to make no allowance for distortion of the eye, but refers the image to its true place were the eye in its natural position.

1. A A Natural single vision.
2. A A A A View with axes slightly converged.
3. A A A View with greater convergence of the optical axes and the two intermediate images coalesced into one.

On suddenly closing either eye, this middle or superimposed image did not disappear, and it was evidently made of two images from *two objects* formed on corresponding parts of the retinæ. Hence we have the converse of the case of double vision of a single object: for two objects are made to produce a single impression. Thus far I had proceeded in 1816, when I read a paper on this subject to a club of my fellow students at Yale.

Experiment III.—In 1843, I made the experiment of converging the optical axes upon two contiguous figures on the wall paper of my office, in the same manner as I had done with the two images of the two candles in Exp. II. When I had thus succeeded in taking up optically the two figures and superimposing them one upon the other, suddenly the whole wall appeared to leap out from a distance of ten feet to within half a yard of my eyes, where it remained in miniature beauty as palpable to vision as it had been in its original place. To this image, suspended as it were between the observer and the object, I shall, in the subsequent part of my paper, apply the term illusive image.

It then appeared that the right eye was directed to the left one of two contiguous figures, and the left eye to the right figure, which being identical in form and size, gave the impression of a single object at the point of intersection of the optical axes. Here we have two triangles formed by the two optical axes intersecting each other and joined at their extremes, on one part by a line from one eye to the other, and on the other part by a line from one figure or object to the other. These last lines being parallel,

(see figure,) where A and B represent the eyes, C and D, the objects, or two figures on the wall; AD the axis of the eye A, BC the axis of the eye B, and E the point of intersection of the axes at the place of the illusive image. As these triangles are equiangular and similar, we can deduce from them all of the equations of such triangles and apply them to the optical phenomena. Thus the distance from the eye to the illusive image (AE) will be to the distance from the object to the same image (DE) as the distance between the eyes (AB) is to the distance between the objects (CD) the figures or pannels on the paper, &c. &c.

It is not merely the two objects directly in the axes of the eyes which coincide, but every contiguous pair of objects seen ob-

liquely will also coincide, and form the illusive picture in extenso. Indeed the optical operation of convergence seems like taking up a duplicate copy of the figures lying in the first place exactly over them, and slipping it gradually to the extent of one figure, until again the figures coincide in a new place.

Some of the phenomena of the Illusive Image.—It is quite perfect, and can be viewed deliberately and critically as if it were a real substance in place as it appears; the figures are smaller than the originals in proportion as they are nearer; as the outlines are a little blended by double pictures not exactly coincident, an elegant softening and a playful beauty exalts their effect above that of the original; as the head moves sideways, upward or downward, the illusive image moves, but with a diminished motion; as the head is inclined to the right or left, the superimposed pictures slide out from each other, the one ascending and the other descending to the extent of the inclination.

Optical Equivalency.—The illusive image and the erroneous distance at which it appears, show evidently that philosophically we do not *see an object*, but we contemplate an image on the retina. If this image can by any means be formed without the object, we still contemplate the substance such as would produce that image. Thus in Experiment III, and the figure illustrating that experiment, the two objects C and D produce each picture in the eyes at A and B, exactly as would be produced by a single object of smaller size at E. Thus the two objects, one at C and the other at D, "fulfill the conditions of the problem" of the images on the retina, exactly as it would be fulfilled by a single smaller object at E. In both cases, identical pictures are formed on "corresponding" parts of the two retinæ. Hence the two objects produce the impression of a single image.

Directions how to make the experiment of the Illusive Image.—With two identical objects only, although it is easy to superimpose them as in Experiment II, yet the illusion of distance can scarcely be attained. But with a papered wall having a repetition of the same figure at equal distances, a person who has voluntary command of the optical axes will soon move the double images to coincide, when presently the illusion will be perfect. Persons who have not this command of their eyes may succeed in obtaining the proper convergence by looking at a finger held about fifteen inches from the face, while standing ten feet from a wall with figures twenty inches apart.

Apparent distances of objects.—It seems that we judge of moderate distances by a kind of triangulation, the distance between the eyes being a constant base line. In order to put this to the test, I have several times made the actual measurements as in the following cases:

Having measured the distance between my eyes, 2·6 inches, the distance between the figures on the wall 21 inches, the distance from the wall ten feet, the distance of the illusive image was calculated to be 14·7 inches, when it had been measured as near as may be 14·5 inches. In a second experiment we endeavored to ascertain the distance of the observer from the wall. The other data were:

Distance between the eyes,	2·6	inches.
Distance between the figures,	21	inches.
Distance of illusive image,	16·75	inches.
Calculated distance of the wall,	12·5	feet.
Measured distance of wall,	13·15	feet.

When it is recollected that the observer is obliged to range lengthwise on his measure while he determines the distance of the aërial image, and that the base line is only 2·6 inches, the above results appear quite as accurate as we ought to anticipate.

There is peculiar beauty and accuracy in some of the results of these experiments, and it had occurred both to Sir David Brewster and myself, that when a strip of wall paper was placed at a greater or less distance from its fellow than others, the illusive image would not appear in the same place, some strips would advance a little and others would recede, so as to fulfill the conditions of the triangles above named; even the sixteenth of an inch would be appreciable.

In the history of my examination of this subject, I would observe that my friend Dr. D. S. C. H. Smith, of Sutton, was present when my paper was read at New Haven. In 1845, my assistant, Thos. K. Beecher, A.M., witnessed and repeated most of the experiments above named. Among other things we made the equations dependent upon the above triangles, and verified our calculations by actual admeasurement of the distances between the eyes, between the objects, and to the illusive image. I attempted a popular lecture on this topic, but found it difficult to interest an audience in a matter requiring so much previous optical knowledge. In the spring of 1846, I communicated the leading principles of what I thought then questionable discoveries, either to Prof. Bache or to Prof. Henry, and consulted him as to their originality. He gave his opinion that they were new. Without the least disposition to contest the point of originality, which I have failed to establish by neglecting to publish my results, I wish merely to inform my friends of what I have in fact done, and thus appear as a collateral witness to the truth and interest of Sir David Brewster's paper. He has brought forward some points which had never presented themselves to me. That figures less distant than the two eyes may be so viewed as to form an illusive image at a greater distance than the object itself, is evidently true, yet I had never made or anticipa-

ted the experiment. Two such small figures might occupy such a situation as to form the pictures on the retina due to a single larger object placed at a greater distance, and thus become an optical equivalent to that object. I am now experimenting on the subject of single vision produced by two identical figures of different colors. So far the results have not excited any very surprising interest. The illusive image, as would be anticipated, usually exhibits the effect of a commingling of the colors, but by directing the attention to one or the other eye, one or the other color may be made to predominate. Thus a cameleon picture is formed, changing color at the will of the inspector.

Sir David Brewster alludes in his paper to some discoveries made by Prof. Wheatstone, in reference to "binocular" vision of objects of three dimensions. I have not seen the paper on that subject, nor had I turned my attention in the least to its consideration, yet so intimately is it connected with the principles just laid down, that upon its being named certain important conclusions at once present themselves. Thus when the hand is held edgewise, within three inches of the nose, one eye will receive an image of the palm and the other of the opposite side, and the two pictures being dissimilar, cannot fall on corresponding parts of the retina and produce a single perfect image. Let any one make the experiment, and he will perceive that Hogarth's caricature of bad perspective, in the figure of a barrel with both ends visible at the same time, was not altogether absurd, for if the barrel be shorter than the distance between the eyes, it is practicable. The same thing will occur with regard to any solid, as a cube, which has several aspects, and the imperfection will be evidently greater as the object is smaller and nearer the eye.

The experiments on this interesting subject can be extended and varied in many ways highly interesting and instructive; and as no other apparatus is required than our eyes and the objects of our inspection, it would seem that they were easily made. But it requires rather an acquired power over the organs of vision to be readily successful. Sir David Brewster applied "binocular" convergence upon two figures, drawn side by side to superimpose one upon the other, and compare their exactness in point of size and form. I have extended the same operation to figures of unequal size, though of the same form. My son had just completed a half size copy of a drawing representing an Arab on horseback, the correctness of which had been questioned. It was evident that being placed at distances proportionate to their size, the images of the original and copy on the retina would be equal when a consistent illusive image might be obtained by convergence. The original was hung on the wall, and the half size copy suspended at about half the distance from the observer, at such an angle that one could be fully seen beside the other. I

converged or superimposed the images, and found them so nearly to coincide, that the common outline was merely elegantly softened by the inequalities. In this experiment it appeared as if the eye, when the figures did not exactly coincide, had some power to complete the work or conceal the imperfections.

I have just succeeded in substituting a blank tablet for one of the pictures, and in tracing upon it with a pencil the illusive image converged from the other tablet. But this is not a very practicable method of copying pictures, requiring unusual command and steadiness of the optical axes for even the most moderate success in the operation.

ART. VII.—*Analysis of the Bittern of a Saline on the Kiskiminetas River, near Freeport, Armstrong County, Pennsylvania;* by M. H. BOYÉ, M.D., A.M.

(Read before the American Assoc. for the Advancement of Science, Philad., 1848.)

THE mother liquid, which remains after the brine has been so far concentrated as to yield no more salt by crystallization, is generally termed bittern, and thrown away. A great difference exists in regard to the quantity of bittern which remains at the different salines, some of them yielding a large amount of it, others leaving hardly any. The bittern which is the object of the present examination, was taken in the fall of 1841, from the first saltwork on the Kiskiminetas river, above Freeport, situated on the canal. It was selected on purpose from this saline, which was said to yield it in larger quantity than any other in the neighborhood, with a view to examine its chemical constituents, and more particularly to test it for *bromine*. Owing, however, to several causes, the examination was not begun till the spring of 1844. In the quantitative estimation of the different ingredients, I have been assisted by Mr. J. Hewston, a pupil of the High School.

The water had during its long standing, deposited at the bottom of the bottle in which it was contained, a crust of common salt, covered with a slight film of oxyd of iron, from which it was separated by careful decantation and subsequent filtration. By a qualitative examination, the water was found to contain lime, magnesia, soda, and a trace of potassa, in combination with chlorohydric acid. By the passage of chlorine through it, and subsequent shaking with ether, the latter assumed a rich orange color, indicating at once the presence of bromine. Chlorid of palladium indicated only a trace of iodine. It contained no sulphuric acid and no lithia.

Quantitative estimation.—1. The specific gravity of the liquid was ascertained, by weighing in a glass bottle, to be 1·339. Its

content of lime and magnesia in combination with chlorohydric acid, rendered it impossible to determine with accuracy by direct evaporation, its content of solid matter. It will however be seen from the following, that the solid ingredients contained in it amounted to 35·79 per cent.

2. A weighed quantity of the bitter water was super-saturated with ammonia, which produced no precipitate, and mixed with oxalate of ammonia until all the lime was effectually precipitated as oxalate of lime. The latter was collected on a filter, washed and incinerated with the usual precautions, and from the weight of the carbonate the amount of pure lime calculated. The filtered solution was evaporated to dryness, the ammoniacal salts expelled by heat, the residuary mass mixed with a small portion of water and oxyd of mercury and again evaporated to dryness, and ignited. On treating the mass with water, the magnesia remained undissolved. It was collected on a filter, washed, incinerated and weighed. The filtered solution was evaporated to dryness, and the weight of the remaining chlorid of sodium ascertained. By subsequent solution in water, and addition of chlorid of platinum and alcohol, it only yielded a minute portion of chloro-platinate of potassium.

3. Another weighed portion of the bittern was diluted with water and mixed with a sufficient quantity of dilute sulphuric acid; then an equal volume of alcohol of the ordinary strength was added to the whole mass. The precipitated sulphate of lime was collected on a filter, washed with a mixture of 5 vol. of alcohol and 6 vol. water, incinerated and weighed, and from it the amount of lime calculated. The filtered liquid was evaporated to dryness and ignited, and yielded the joint weight of the sulphates of magnesia and soda. These were then dissolved in water and precipitated with acetate of baryta. The filtered solution was evaporated to dryness, charred, and by treatment with water the carbonate of soda dissolved from the insoluble carbonates of magnesia and baryta. The former was separated from the latter by extraction with dilute sulphuric acid, and the amount of sulphate of magnesia estimated. Deducting the latter from the joint weight of the sulphate of magnesia and soda, the amount of sulphate of soda was obtained, from which that of the soda was calculated. As stated above, it only contained a small amount of potassa.*

4. Another smaller portion of water was acidulated with a few drops of nitric acid and then precipitated by nitrate of silver, and the weight of the chlorid of silver with its smaller contents of bromid and iodid of silver ascertained.

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* This method of separating lime when in preponderating quantity by sulphuric acid and alcohol, the convenience and accuracy of which I pointed out in an essay on the analysis of *magnesian limestones*, by R. E. Rogers and M. H. Boyé, Journ. Franklin Inst., March, 1840, I cannot sufficiently recommend.

5. The accurate quantitative determination of bromine in connection with larger quantities of chlorine, is as is known connected with difficulties, and different experiments performed after the different methods recommended, yielded different results varying from 0·3 to 1 per cent. The result adopted in the following, was obtained by distilling a certain quantity of the water with peroxyd of manganese and a small but sufficient quantity of chlorohydric acid, receiving the bromine in a small globular receiver containing ammonia, and in the tubulure of which was fixed a modification of Liebig's potassa bulb, as employed by Will and Varrentrap in the analysis of nitrogenized organic compounds, but in this case containing, like the receiver, ammonia. The chlorid and bromid of ammonium thus obtained were decomposed by evaporation to dryness with caustic baryta, the mass treated with water, the excess of baryta precipitated by carbonic acid, and then the bromid and chlorid of barium precipitated by nitrate of silver, and the weight of the bromid and chlorid of silver ascertained after perfect desiccation on a counterpoised filter. It was then treated with nitro-muriatic acid by heat and its weight again ascertained, and from the difference in weight the amount of bromine calculated.

6. The amount of iodine was determined by precipitation of chlorid of palladium, and ascertaining the weight of the iodid of palladium.

Taking the mean of §§ 2 and 3, the results of the analysis were as follows:

	In 100 parts of the water.
Potassa,	0·081
Soda,	0·464
Lime,	12·560
Magnesia,	4·200
Chlorine,	23·068
Bromine,	0·701
Iodine,	0·0035

from which the following composition of the water may be derived.

		In 100 parts of the water.	
Chlorid of potassium,		0·128	
Chlorid of sodium,		0·877	
Chlorid of calcium,		24·640	
Chlorid with Bromid and Iodid of	magnesium,	10·146	Mg. 2·575 Cl. 6·866 Br. 0·701 I. 0·0035
Water,		64·209	
		100·000	

Philadelphia, Nov., 1844.

ART. VIII.—*On the Comparative Value of different Kinds of Coal for the purpose of Illumination; and on Methods not hitherto practised for ascertaining the Value of the Gases they afford;* by ANDREW FYFE, M.D., F.R.S.E., F.R.S.S.A., Professor of Chemistry King's College University, Aberdeen, &c. Read before the Royal Scottish Society of Arts, April 24, 1848.*

IN a paper published in the Transactions of the Society for 1842, I gave an account of numerous trials made with the view of ascertaining the value of different kinds of coal for the purposes of illumination. Having been again engaged in conducting experiments for the same purpose, I have been induced to make some of the results public, because I conceive that they are interesting, and lead to valuable practical applications.

The objects which I have had in view were to ascertain not only the *comparative amount of light* afforded by the gases which the coals yield, but also the *durability* of these gases, so as to enable me to fix, as far as possible, their *comparative value*, and, consequently, their comparative *expense*, for the purpose of illumination. Besides these, however, my attention was drawn to other circumstances connected with the consumption of gas, which, strictly bearing on the other part of the inquiry, are of importance.

1. *Quality of the Gases.*

In estimating the quality of coal-gases, and, consequently, fixing their comparative value for the purpose of illumination, we must take into account both the light afforded, and the time required for the consumption of equal volumes.

In trying the former, I have, in the following experiments, invariably had recourse to the method mentioned in my former papers, viz., the condensation by chlorine, and in which, now that the trials have been greatly extended, I place the utmost confidence.

For ascertaining the latter, I have followed the usual method,—an accurately-adjusted experimental metre; by which the times required for the consumption of equal volumes, burning under similar circumstances, and also the quantity consumed in equal times, were easily determined. The jet burner was the same in all the trials.

I consider both of these circumstances absolutely necessary, for, though some have insisted only on the one, and others on the other only, yet, unless both be taken into account, we do not

* From Jameson's Jour., Edinburg, vol. xlv, pp. 37—49.

arrive at the true *value* of the gases, and, consequently, cannot compare one with another for the purpose of illumination. Thus, if two gases afford, by their combustion, from the same or similar burners, with the same height of flame, the same light; but if a foot of the one lasts an hour, and a foot of the other an hour and a-half, then the latter is one-half more in value than the former for yielding light, because it is giving the same light for one-half more time; or, which is the same thing, one-half more of the former must be used so as to complete the time which the latter will burn. This, I regret to say, has been too often overlooked by many in estimating the value of coal-gas.

As the chief object I had in view was, not the comparison of the light afforded by coal-gas, or its expense, as compared with other sources of light; but merely the value of the gases as *compared with one another*, when obtained from different coals, I shall commence with that from English caking coal, and take it as the unit for comparison.

English Caking-Coal Gas.—The gas from this kind of coal, on which my experiments were made, was that from Newcastle; others were also procured by means of an experimental apparatus, fitted up expressly for the purpose. The condensation by chlorine in the former, was, on an average of several trials, 4·33 per cent.

The specific gravity, at Th. 60, B. 30, was 420.

The durability, with a four-inch flame, from a platinum jet, $\frac{1}{33}$ of an inch in diameter, was 1 cubic foot in 50 minutes 30 seconds. The pressure by water-gauge at the burner was $\frac{1}{10}$ of an inch.

From 1 ton of coal, about 8000 cubic feet of gas are obtained.

The gases obtained with my experimental apparatus, from a variety of samples of the same kind of coal, both lately and several years ago, were very nearly of the same composition. Different heats were used in driving off the gas, with the view of finding the best heat. The condensation by chlorine varied from 3·5 to 5·5; the average of the trials, amounting to eight, was nearly 5. The durability varied from 47′ 20″ to 53′ 30″; the average being 50′ 25″.

The average specific gravity of eight different gases was 464, the highest being 512, the lowest 414.

As above mentioned, I take the gas from this kind of coal for illuminating power and durability, and, consequently, for *value*, as my standard of comparison.

English Cannel-Coal Gas.—The gas obtained from this kind of coal, such as that from Wigan in Lancashire, with which Liverpool, Salford, and other places are supplied, and that from coals found in different parts of Yorkshire, which are occasionally used at Manchester, are very nearly of the same quality.

The *Yorkshire Parrot Coal*, in its appearance and quality, is altogether different from the English caking coal. It more nearly resembles the parrot coal of Scotland. The condensation by chlorine was 7·66; the durability, 52′ 30″; pressure at burner, $\frac{6}{10}$. A ton of coal yields about 11,500 feet.

I have already stated, that the chlorine test, with English caking-coal gas indicated 4·33, that with the Yorkshire cannel-coal gas being 7·66; consequently, the illuminating power is as 1 to 1·76. The durabilities being 50′ 30″, and 52′ 30″, they are as 1 to 1·03; both taken together, makes the value of the latter, for the purpose of illumination, 1·81, to the former, as 1·(1 : 1·76 :: 1·03 : 1·81).

Wigan Cannel-Coal Gas.—I have had several opportunities of testing the quality of gas from this kind of coal, as at Liverpool, Salford, &c., at which the gas was found to be of the same quality. The chlorine indicated 7·55. The durability was 57′; the pressure at the burner, $\frac{8}{10}$ths and $\frac{9}{10}$ths; sp. gr. from 460 to 520. The quantity of gas from a ton of coal was 9,500 feet.*

Newcastle coal-gas being by the chlorine 4·33, and the Wigan cannel gas, 7·55, they are as 1 to 1·73. The durability being 50′ 30″ and 57′, they are 1 to 1·12. Taking both into account, then the value is as 1 to 1·93 (1 : 1·73 :: 1·12 : 1·93), which is nearly the same as that of the gas from Yorkshire cannel, already given as 1·81. We may take the average value of the gas from English parrot coal, so far as these trials go, as 1·85, compared to that from English caking coal, as 1.

Scottish Parrot Coal.—I have had many opportunities of testing the quality of gas from this kind of coal, not only as manufactured at gas-works, but also when made by my experimental apparatus in Edinburgh and Aberdeen. I have already in a paper, published in the Transactions of the Society, for 1842, given the results of numerous trials conducted in Edinburgh. I have now to allude, not only to those made in different towns of Scotland, but also to a very extended series, more lately carried on with the experimental apparatus.

The gas, from all the varieties of Scottish parrot coal, is of superior quality to that from the best English parrot; but it varies very much according to the kind of coal. In all of the towns in Scotland that I have visited, a mixture of one of fine quality, and of one or more of inferior quality, is employed in the manufacture of gas; partly, because the former cannot be got in sufficient quantity; partly, because it is too expensive; and hence, with one or two exceptions, chiefly in the smaller towns, the quality of the gas was found to be very nearly the same.

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* In one instance I found the quantity of gas amount to 11,500 feet; but in this case the quality of the gas was not so good. I prefer, therefore, taking the one above.

In the paper already alluded to, I have stated the condensation by chlorine, with the gases prepared from the coals there mentioned, to vary from 9 to about 20. With two exceptions, I never found it under 12; the average of all the trials, amounting to upwards of 20, may be taken as 15, that is, very nearly double of that with the English cannel coal; and 3·46 as great as that with the English caking coal; thus making the illuminating power, English caking 1, English cannel 1·85, Scottish cannel 3·46. The English cannel being 1, the Scottish cannel is 2, or very nearly so.

The trials with the same gases shew the durability to vary from 56′ to 94′, with the two exceptions above mentioned, it was not below 70′—the average of the trials was 80′; making the durability as 1·58 to the Newcastle, and 1·48, or 1·45 to the average of the English cannel as 1. Now, taking both into account, the value of the Scottish parrot-coal gas, bulk for bulk, for affording light in these trials, is as 5·46 to Newcastle as 1, and 2·68 to English parrot as 1.

Since these experiments were made public, I have been engaged in a very extensive series of trials with parrot coals procured from Fifeshire, the Lothians, and the Western districts of Scotland, so as to ascertain the value of the gases which they afford. The gases were manufactured with the experimental apparatus, and under a variety of circumstances, so as not only to secure accuracy, but also to observe how far the manufacture, &c. is affected by a difference in the mode of conducting it. It is not my intention to allude to these farther than to state, that, taking the average of the trials, amounting to upwards of 40, I found the chlorine test, and the durability to be very nearly the same as those given above.

With regard to the gas with which the towns in Scotland are supplied, I have already said, that in manufacturing it, a mixture of different kinds of coal is employed, according to the situation of the town, and the supply that can be obtained. At Edinburgh, the coal is chiefly from the Lothians and from Fifeshire. At Glasgow, it is got from Lesmahago, Kelvinside, Wilsontown, &c. At Greenock, Monkland and Skaterig coals are employed. In the towns in the north of Scotland they are obtained chiefly from Lesmahagow and Fifeshire.

The price of coals varies according to the kind of coal. At Edinburgh and in the west, it is from about 20s. to 23s. per ton. In the north, however, it becomes higher and higher, according to the distance, and, consequently, to the carriage from the pits.

In the larger towns that I have visited, I have found very little variation in the quality of the gas obtained from the different mixtures used. The chlorine indicated from 13 to 15; the average may be taken as 14. The durability was from 70′ to 90′,

very rarely below 80,—on an average, it was a little beyond 80, say 80. The pressure at the burner varied from $\frac{6}{10}$ ths to $\frac{7}{10}$ ths. The sp. gr. was, on an average, about 6·40. Thus, then, the illuminating power of the gas with which the towns in Scotland are supplied, is, on an average, as 3·23 to the Newcastle coal gas, and 1·85 to the average of English cannel, both taken as 1. The durability is as 1·58 to English caking, and 1·45 to the other, both as 1. Accordingly, taking both into account, the value of these gases, bulk for bulk, for the purpose of illumination, is English caking 1, English cannel 1·85, the average of the gas in the towns of Scotland 5·1, say 5. Taking the English cannel-coal gas 1, then the Scottish is from 2·63 to 2·72, say 2·7. From the mixed coal employed in different towns, a ton yielded on an average 9500 feet of gas.

2. *Value of Coals for the purpose of Illumination.*

Keeping in view what has now been said regarding the quality of gas which the different kinds of coal afford, an estimate may be formed of the comparative value of these coals for that purpose, independent of the price paid for the coals, and also of the returns made for coke, and other matters disposed of, such as ammonia, &c.; and in doing so, I still take the *English caking coal as unity.*

A ton of English caking coal yields, on an average, at gas-works, 8000 feet of gas, and though a larger quantity was given with my apparatus, yet we must take 8000 as the quantity on a large scale. The value of the coal is taken as 1.

The *Wigan cannel* yielded 9500 and 11,500; the value of the gas, bulk for bulk, being the same, viz., 1·85 to the former as 1. Now, taking into account the quantity of gas afforded, the value of the coals for yielding light, by the consumption of their gases, is as 2·23 for the one quantity, and 2·5 for the other; taking the average, we state the value of English cannel coal as 2·35, or say $2\frac{1}{3}$ to Newcastle caking coal as 1.

Scottish Parrot.—While the English cannel coal may be considered as of the same value at different places, it is not so with the Scottish parrot. I have said that it varies very much in different districts; and hence, though the value of the gases with which the different towns are supplied is very nearly the same in all, owing to mixtures of coals of superior and inferior quality being used, yet the value of the different coals varies considerably, owing to the quality and quantity of gas which they afford varying.

I have taken the average value of the Scottish parrot-coal gas as 5, compared to that from the English caking coal as 1. The quantity of gas from the latter being 8000, and that from the

former 9500, then the value of the coals for the amount of light afforded by the combustion of their gases, is as 6·1 to 1.

The above must be considered as the value of the Scottish parrot coals *on an average*, or as used in their *mixed state*, as is generally done by gas companies. It may be interesting to state the value of some of the coals themselves. The poorest Scottish parrot I have yet examined yielded only 9000 feet of gas, the value of which was 2·2 to that of English caking-coal gas as 1; making, accordingly, the value of the coal for yielding light only 2·5, or very nearly so.

The value of the gas from Lesmahago coal, which by gas-makers is generally considered the best in the market, I have found to be 6·6 to the English caking-coal gas as 1; the quantity of gas being 1·13 to 1; accordingly the value of Lesmahago coal is at least 7 to 1. Since the publication of my paper in 1842, I have had more valuable coals submitted to trial; but as these are not, so far as I know, in the market at present, they must not be taken into account in fixing the average value of Scottish parrot coal. As above stated, we must still consider the value of this coal as about 6, to the Newcastle caking as 1; of course its value compared with the English cannel, will be 2 6 to 1.

I have said that the value of the coke has not been taken into account in these calculations; it must, however, be borne in mind, that, while I have fixed the value of the Newcastle coal for affording light by the combustion of its gas, as very low, compared to that of the cannel coals, yet, taking into account the greater quantity of coke which it yields, and the higher price at which that coke is sold, the value of the coal to gas-manufacturers becomes comparatively greater than I have stated, of course, in this point of view, reducing the value of the others as compared with it; but then this has nothing to do with the question under consideration, viz., the comparative value of the coals for affording light by the combustion of their gases.

3. *Expense for Light by different Gases.*

Having fixed the value of the gases obtained from the varieties of coal mentioned, I have now to advert to the prices paid for the gases at different places, with the view of shewing the comparative expense to consumers for the same amount of light.

In examining this part of the subject, a difficulty occurs, owing to the different methods followed in charging for gas in different towns. The following remarks must therefore be considered only as an approximation to the truth.

English Caking-Coal Gas.—The charge for this gas is about 4s. 6d. per 1000 feet, as at Newcastle, subject to discount, by which, and by charge for street-lamps, the average price may be taken as 3s. 10d. Let us take this as unity.

In the different towns I have visited in England, where *English cannel coal* is used, the charge varies from 4s. 6d. to 5s. 6d. Suppose we take the average at 5s., then the comparative charge for it, and for English caking-coal gas, is as 1·3 to 1. But the value of the gases, bulk for bulk, for the purposes of illumination, being as 1·85 to 1, then the comparative price paid for the same amount of light is only 75 to 100.

The price charged for the *Scottish parrot*-coal gas varies considerably in different towns, owing chiefly to the difference in the expense of coal. I have found it to vary, in the larger towns, from 5s. to 7s., but, making allowance for discount, it goes from 5s. to 6s. 6d. Taking it as 5s., then the charge, compared with the English caking-coal gas, is 1 to 1·3; taking the *value* of the gases into account, the price paid, for equal amounts of light, is as 25 to 100; accordingly, to light to the same extent with these gases, the expense for the English gas is four times as great as that for the other. At 6s. it would be 30 to 100, and at 6s. 6d. it would be 33 to 100; and hence the price paid for equal amounts of light varies from one-third to one-fourth of that paid for the English caking-coal gas.

I have given the comparative value of the English parrot-coal gas, and of the Scottish, as 1 and 2·7, the average price for the former being 5s., that for the latter 5s. 6d., and 6s. 6d. For the first, the price paid being the same, the expense for equal lights will be inversely as the value of the gases, 2·7 to 1; at 6s. 6d., the highest charge, the comparative expense is about 2 to 1. Accordingly, the expense paid for the same extent of lighting by these gases, varies from about 2 to 2¾ for the English, to the Scottish as 1; that is, the expense for a given amount of light, for a certain time, by Scottish gas being 1, that for the same light, during the same time, with the English parrot-coal gas, is from 2 to 2¾, and for the English caking-coal gas, from 3 to 4, according to the price paid for the Scottish gas.

In making these remarks regarding the value of the gases in different places, and the consequent prices paid for equal amounts of light, I trust it will not be supposed, that I mean to insinuate that the price paid by consumers of gas in England for their light is too great, and that consequently, it ought to be reduced, so as to bring it to a par, or nearly so, with that paid in Scotland. So far from that being the case, I believe, that, at present, some English gas companies are charging for their gas a price which does not remunerate them; and that, instead of it being lowered, it ought to be raised. It must be borne in mind, that the price of gas, like that of other manufactured goods, must be regulated, in a great measure, by that paid for the raw material; and it so happens that, in England, they are not so fortunate as we are in Scotland, where there is a coal, which, though much more

expensive than the English coal, yet is superior to it for the manufacture of gas; in so far that it yields an article of much higher value for the purposes of illumination; but, then, were this coal used in England, it would, most probably, owing to carriage, &c., become so expensive, as to cause the charge for the same light to be greater than at present.

In considering the results of the trials now recorded, the most superficial observer must be struck with the remarkable fact, that gases, having the same illuminating power, require, with the same burners, very different times for the consumption of equal volumes; and hence, as I have already said, it is necessary, in ascertaining the *value* of a gas, for the purpose of illumination, to take into account, not only the illuminating powers, but also the durability. Though I alluded to this in a former paper, published in the Transactions of the Society for 1842, my attention has been more particularly drawn to it during the investigations in which I have been lately engaged, by observing the striking difference between the durabilities of gases obtained from Scottish cannel coals, procured from different districts; and hence, the remarkable circumstance, that two coals may both yield the same quantity of gas, and which gases, when burned under similar circumstances, are of the same illuminating power, yet these coals may be of different value for the manufacture of gas, in so far, that the gas from the one will burn a longer time than that from the other will do, when consumed in the same way. This is well illustrated with the coals of the Lothians, and of the west of Scotland. Thus, the average condensation by chlorine, of the gas from the Marquis of Lothian coal, was, in my trials, 13·125, the average durability 59′ 30″; while, with the Lesmahago coal gas, the former was 15·77, but the latter was only 62′ 24″. Had the one been in proportion to the other, the durability ought to have been 71′ 30″, or nearly so. The same remark is applicable to the varieties of coal from the west of Scotland, when compared with one another. Thus, the average indication by chlorine, with Skaterig and Knightswood coal gas, was 9, the durability 46′ 45″. With the Lesmahago, as above, they were respectively 15·77 and 62′ 24″. The latter, to keep pace with that of the former, ought to have been 81′ 54″.

I have observed similar results in trials which I have lately made. Thus three coals, submitted to experiment, yielded gases, the indication of which, by chlorine, was 14; the durability in the one being 57′, in the other two 66′; and again, with other gases, in which the condensable matter was as high as 19 and 22, the durability did not exceed 77′ and 81′. In numerous trials I found that the gas from English caking coal gave condensation by chlorine 4·33, and durability 50′ 30″, or nearly so. That

from Wigan cannel coal had condensation as 7·5, but the durability was only 57′; the Yorkshire cannel-coal gas was, condensation 7·66, and durability only 52′ 30″. Had the durability of the English cannel-coal gas kept pace with the condensation test, it ought to have been at least 87′ instead of 52′ and 57′.

It is evident from this that the durability is affected by other circumstances than the presence of the ingredient, whatever it may be, which causes the condensation by chlorine, in other words, than by the illuminating power.

Considering this still farther, I observed a remarkable coincidence between the durability and the specific gravity, as is shewn in the following table :—

Specific gravity, . . .	620	627	645	659	704	740	836
Durability, ...	55′	64′	66′	67′	77′·5″	91′·7″	106′

In the above table it is shewn, that as the specific gravity becomes greater, the times required for the consumption of equal quantities become longer; but the increase of the one does not keep pace with that of the other. There is, however, some connection between them, and on farther investigation it occurred to me, that perhaps the consumption of gases by combustion is regulated by the same law as the diffusion of gases, as pointed out by Professor Graham, viz., that *under equal pressures the diffusion is inversely as the square roots of the specific gravities*. Accordingly, in equal times, the *consumption* should be inversely as the square roots of the specific gravities; and conversely, the *times* for the consumption of equal volumes, from similar burners, and under the same circumstances will be as the roots of the gravities.

Again, if this be true, then, under different pressures, the escape should be as the square roots of the pressures; and, accordingly, the time for equal consumptions should be inversely as the roots of these pressures.

To put this to the test of experiment, I procured a platinum jet, furnished with a graduated pressure gauge, and adapted it to an experimental metre, by which I could consume the gas, under the same and different pressures, and mark the quantity consumed in a given time; and consequently the times for the consumption of equal quantities. The gauge had a vernier fitted to it, by which I could easily read off to one-hundredths of an inch. The temperature and barometer were also noted for each experiment, and the specific gravity, when necessary, was ascertained in the usual way.

The following are the results of trials made for the purpose of putting these opinions to the test.

Consumption of Gases under different Pressures.

Numerous experiments were made for ascertaining this, first with gauges of small diameter, the results of which did not agree

with each other; but when the diameter was about half-an-inch, they more nearly corresponded.

I give the following from among many :—

Burners.	Pressure	Square root of Pressure.	Consum't by Metre.	Consumpt by Calculation.	Difference.
Jet,	4	2	2·2	2·2	...
	8	2·82	3·3	3 3	...
	16	4	4·8	4·4	0·4
Jet,	3	1·73	2 6	2 6	...
	6	2·65	3·6	3·9	0·3
	12	3·47	5·8	5·2	0·4
Jet,	8	2·82	7·01	7·01	...
	16	4	10·511	9·92	0·59
Jet,	50	7·07	5·07	5 07	...
	100	10	7·06	7·07	0·01
	200	14·14	9·64	10·14	0·50

The following are the results with different kinds of burners, the trials having been conducted with the view of ascertaining the illuminating power by these burners :—

Small Fishtail,	34	5·83	1·41	...	...
	77	8·79	2 16	2·13	0·03
Large Fishtail,	48	6 92	2 27	...	...
	97	9 84	3·3	3·2	0·1
Large Fishtail,	50	7 07	2·2	...	...
	70	8·36	2·5	2·6	0·1
Large Batwing,	70	8·36	3·1	...	...
	140	11·8	4·5	4·37	0·13

From the above it will be seen that the escapes are very nearly as the roots of the pressures.

(To be continued.)

Art. IX.—*Mineralogical Description of the Island of Bánká;* by Thomas Horsfield, Esq., M.D.*

After the foregoing geographical description of Bánká, I proceed to a connected narrative of the mineralogical features, in order to explain the constitution of the mines, and to throw some light on the geological history of the island, reserving the most obvious conclusions and reflections until the observations made in different parts of the island have been detailed, and may be taken into one point of view.

But, for the purpose of elucidating the following descriptions, it is necessary to make some remarks or positions of a general nature.

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* From the Journ. of the Indian Archipelago and Eastern Asia, vol. iii, No. vii, 1848, p. 398. The article cited, follows a detailed geographical description of the island.

1. The direction of the island is from northwest, to southeast: in this direction it follows, not only the neighboring island of Sumatra and the peninsula of Malaka, but the large chain of the Asiatic mountains, one of the various branches of which terminates in Ceylon, while another after having traversed Arracan, Pegu, Malaka and probably Sumatra, sends off an inferior range through Bánká and Billiton, where it may be considered to disappear and terminate.

2. It is not only in the direction of its course that Bánká follows the large Asiatic ranges of mountains; the elevated parts of the island, or those which are entitled to be called mountains or hills, have the same constitution as the great chain above mentioned: they are composed principally of *granite*.

3. Next to these, which must be considered as the more important part of Bánká, we meet with a species of rock, which for the sake of distinction I have named red ironstone. It is very extensively distributed and occurs in situations of secondary elevation, in single beds, or in veins of many united together, and covering extensive tracts of country. The red color universally predominates, and it contains a large proportion of iron in its composition; but a more particular account of its distribution and conjunction with other parts of the island, is one of the chief subjects of the following description: the analysis will be added separately.

4. In many parts of the island, these tracts of country, which are composed of red ironstone, are bounded by the *alluvial* districts. These are again subdivided into such as are formed of ranges of waving hills, gradually rising on each other, apparently of prior formation, and such as are completely low and level, of recent origin, and confining the discharge of the large rivers.

5. In conjunction and often within the alluvial tracts are found sandstones, breccias (or puddingstones), and various mixed stones, bearing marks of a comparatively late origin. The former are generally distributed in extensive veins or low ridges; the breccias occur in a great variety of form and disposition. Immense conchoidal or tabular masses, in some instances, cover extensive portions of the ground.

6. Those districts which occur in juxtaposition to the primitive portions, filling the space between these and the fixed veins of red ironstone (iron-rock), or again between these and the alluvial parts, are *stratified*: the strata are uniformly horizontally arranged, and characteristic of the tracts above mentioned, which form the basis of the island.

7. The *ore of tin* is disseminated through these horizontal strata, and, as far as has hitherto been remarked, either immediately under the surface or at no great distance below it; they are mostly found in low situations or near the primitive ridges. The

process of mining has greatly contributed to illustrate their composition; and it is one chief object in the following details to give a clear account of the component parts of the strata, in as far as these were illustrated by the various fragments of stone found at the aqueducts of the mines.

8. Forming part of these strata and distributed through the more solid parts, are extensive masses of *clay* of various colors, from pure white to yellow and red; a black earthy substance which, for the sake of distinction, I have called *black clay*, occurs in irregular masses (with few exceptions) in every mine; and the termination of a stratum is indicated by a peculiar white clayey substance which becomes friable by drying and is called *Kongtay* by the Chinese.

I have proposed in the mineralogical remarks, to follow the order in which they were made during a tour through part of the Island of Bánká, without any respect to regularity or relative importance; dating the commencement of my investigations from my arrival at Kámpák, in March, after a passage of two days from the settlement of Rángám. In my course around the western extremity of Bánká, during which the vessel remained near the shore, I had a good opportunity of observing the direction and extent of the mountain Mánumbing and its western and eastern appendages, with part of that range which extends from it, to the eastward.

That tract of country which lines the Bay of Jebus between the hills of Pári-pári on the north, and of Mánumbing and its appendages on the south, must be considered as one of the alluvial districts of Bánká; besides several others of less note, the rivers of Sungeibulo, Kámpák, Pálungás and Rámbát pass through it. In proceeding up the river of Kámpák, I remarked numerous rocks projecting beyond the surface.

I examined them at a cluster which forms a small island called by the natives *Bátu-lulut*, about one hundred yards in circumference. The external form of the entire rocks is rather rounded than sharp; the highest project, at the present season, about ten feet beyond the level of the river. The external color of the rock is of a dirty hue; the surface is very unequal and rough, excavated by fissures, crossing each other in various directions, into irregular angles and rhombs, &c., or marked in a similar manner by white streaks or veins. The fracture is intensely white, some portions appearing glistening as pure quartz, others dull and chalky.

When struck with a hammer, it separates at the fissures, which appear on the surface, into irregular fragments. It also frequently follows the direction of the streaks or lines: these are formed of quartz, and are semi-transparent, frequently approaching the nature of rock-crystal. They often separate from the common mass of the

stone into extensive laminæ of unequal thickness from half a line to a quarter of an inch. In many cases, however, they are closely united to the substance of the rock—they appear on the fracture but cannot be separated. This rock is completely siliceous, and exhibits not the least effervescence on the application of the acids.

The village of *Kámpák* is situated about half a mile from the discharge of this river; the banks are here elevated about twelve or fifteen feet above its common level at low water. After some search I discovered a spot where they were exposed by an artificial section; they there consisted of a stratum of red ironstone formed of fragments of various figures, from the size of a pea to that of several inches in length and diameter, disposed in very fine sand, adhering partially by means of particles of clay; they were all rounded at their edges and bore the marks of having been carried down by the stream. Alternating with this stratum, and in some instances immediately under the soil, I remarked extensive masses of clay of a reddish ground, variegated with yellow and white; small fragments of ironstone were often bedded in it.

From Kámpák, the direction of the river is winding through the alluvial plain to its third branch, which leads to the stockade of Jebus; the profusion of vegetation along the whole course, extending completely to the water edge, prevents an accurate examination of the banks; in several places where they were exposed they exhibited a black vegetable mould. The stockade of Jebus is built on the first elevation beyond the level of the river: I examined the fragments of stone which were thrown out in making the ditch which surrounds it; they are of the same kind as those found near the river at the village of Kámpák, small red ironstones all bearing the marks of attrition, corroded on the surface, flat, oblong reniform. variously excavated, perforated and rounded; the fracture exhibited a red or brown oxyd of iron of different shades, the surface was covered with a yellow ochreous crust.*

The country from the stockade of Jebus to the district of the mines is waving and uneven, but as it is completely covered with wood and vegetables, it is difficult to form an opinion of the relative height of the intervening hills, which may more properly be called risings. I noticed thirteen in succession on this tract.

In the descent after the first rising, large rocks of red ironstone projected from the surface, or were dispersed in large fragments on the road. The fracture is very various; in some fragments it is metallic, in others ochreous or mixed; those of the former (the

* The disintegrated ironmasked rocks of the Peninsula are extremely deceptive in this respect, often appearing like water worn gravel, volcanic lapilli, &c.—Ed.

metallic fracture) are of a dark brown color, laminated or cellular, the excavations exhibiting a dark shining surface and resembling a substance which has undergone fusion and suddenly cooled; the ochreous fracture is generally porous and the color intensely red. Both are a rich iron ore, and their analysis and accurate description will be given in the sequel.

The following nine valleys exhibited similar appearance. The red ironstone in great variety; and *sand*, apparently of different colors, from the clayey particles that are accidentally mixed with it; several of them transmit rivulets, others bear the marks of an accumulation of water after rains.

In the ascent after leaving the tenth valley, the road crosses a very extensive layer of *sandstone.* The color, in general, is light blue or inclining to grey; some parts are covered with a yellowish ochreous crust. It is divided or separated by rightlined fissures, which appear on the surface in delicate lines or streaks crossing each other in various directions: when struck, it separates at these lines, in fragments of every variety of configuration, with flat sides and sharp angles, forming squares, lozenges, pyramids and oblique parallelograms in endless variety. The adhesion of its particles, in its natural situation, is not strong and many portions are friable; by drying, it acquires a considerable degree of hardness. On this layer of sandstone I found, dispersed in various parts, loose fragments of a substance purely siliceous, consisting of minute crystals of quartz closely united into a brittle mass, divided and separating by regular fissures, but mostly in planes or slabs with even surfaces. In the eleventh and twelfth valley are dispersed large loose fragments of red ironstone, similar to those above described: they both transmit small rivulets. After the thirteenth descent, follows that district in which the mines are at present worked. Its boundaries and extent cannot be defined, but the most productive strata of tin ore have been found near the central parts of this peninsula, at the junction of the districts of Sungie-bulu, Klábet and Tengá, embracing an irregularly oval space, whose longest diameter is about six miles, sending off arms in various directions, particularly towards *Klábbet-lámá* or to the northeast. Towards the north and northeast the plain is surrounded by the ranges of hills above mentioned; in the southwest and south, it unites with the alluvial hills, which stretch obliquely across this part of the island, and its south and southeast extremities extend to that large desert, surrounding the mountain of Márás, which has been imperfectly investigated.

This district, upon the whole, is level or variegated with very gentle risings; but like most parts of Bánká, it is so completely covered with vegetation, that in no place can a large extent of surface be taken into view at once.

Of all the mines that are worked at present, in this district, those of Jebus or Anten are the most considerable; they are divided, according to their situation, into those of the *Upper-furnace*, and of the *Lower-furnace;* in the former two, and in the latter three large mines are worked at present, besides ten *small* ones distributed through both districts.

The large mines of the Upper-furnace district are those of *Sungie Tángo* and *Suntáy*, and of the Lower-furnace district, those of *Sungie-Bulák*, *Táynám* and *Seám:* the ten small mines of both districts are those of *Sunko*, *Sunyu*, *Sunsing*, *Sunwad*, *Sunwing*, *Sunhawa*, *Soktjoy*, *Tempo*, *Assun*, and *Atshey*.

The first mine, near the southern boundary of the district which I examined, was that of Sungie-Bulák, named after a river of the same name; the ground in the neighborhood has been worked for nearly thirty successive years.

As the manner in which the business of mining is conducted on Bánkâ, will be minutely described in the sequel, I shall, at present, only premise, introductory to the description of the appearances which I noticed under the surface, that, in large mines, the ground is perforated by a square or oblong excavation or pit, from which the successive layers are carried out by the workmen until they arrive at the stratum which contains the ore of tin. These strata, as has already been remarked, are all disposed horizontally, and, comparatively, at no great distance below the surface; extensive tracts of ground are thus, in many places, worked and exposed in succession. In this place particularly, where the stratum had been found very productive, I observed the remains of a great number of pits, from which the ore had been extracted.

In the pit on which the workmen were at that time employed, I noticed the following succession of strata:

On the west side.

No. 1.	Stratum, black vegetable mould,	1 foot.
2.	Sand and yellow clay loosely mixed,	1 "
3.	Black clay, an extensive irregular mass unequal in depth, from	6 to 8 ft.
4.	Coarse white sand,	3 feet.

On the north side.

1.	Stratum, black vegetable mould,	1 foot.
2.	Sand disposed in dark colored clay (irregular),	3 feet.
3.	Black clay, variegated with narrow strata of yellow clay; irregular massive,	5 to 6 ft.
4.	Coarse sand,	3 "

On the south side.

1.	Stratum, vegetable mould,	1 foot.

2. Sand mixed with mould (containing trunks of trees in a recumbent position; and perforated by deep roots), ... 9 feet.
3. Yellow clay in small irregular layers alternating with dark colored sand, ... 1 foot.
4. White clay, ... 6 inch.
5. Black clay massive, ... 1 foot.
6. Coarse sand.

The miners were at this time engaged in carrying out these different strata; they had penetrated nearly fourteen feet below the surface, and from the disposition of the vein of ore, with which they were acquainted by the experience of the last pit, they expected to arrive at it after having descended about six feet more. On the surface remaining exposed from the former works, I observed very large fragments of a glistening white stone consisting of quartz and feldspar mixed nearly in equal proportions. Some of them were more than twelve inches in diameter. If force was applied they separated at fissures into fragments with regular sides. They had remained after the *washing of the ore;* the fragments of stone which remain, after this process, at the sides of the canals or aqueducts, demonstrate clearly the composition of the stratum in which the ore is found, and I made it a rule to examine them in every mine I visited, and to collect specimens of the varieties.

At this place I found, besides the large fragment above mentioned, smaller particles, diminishing gradually to the weight of a few grains of the same kind; they all had a disposition to separate into fragments with regular angles. In some cases the particles of feldspar were in a state of decomposition and formed a white powder resembling chalk; it was not in the least affected on the application of the strong acids. Small crystals of pure quartz were mixed with this white powder.

Besides these, I found at the aqueduct, sandstone in small fragments, resembling that above described. An aggregate stone or conglomerate in laminæ, composed of particles of quartz united by a yellow, ochreous iron-earth; to several of these the particles of tin ore were still found adhering, and irregular fragments and crystals of pure quartz of various shades of color.

In proceeding from the district of the Lower to the Upper furnace one perceives, on the road, the vestiges of many of the old mines; they form a contrast, though by no means a pleasant one, with the abundant vegetation of the island; the places of the small mines present a naked uneven surface, covered with the remains of the former works, to which the shining particles of quartz mixed with the sand impart a peculiar aridity; the place of the large mines is known by extensive chasms alternating with irregular hillocks. It requires however, but a short time in

Bánká, to cover the whole with fresh vegetation, and in a few years the spots where the mines were worked are converted again into forests.

The mine of *Sungei-Tángo*, is the most important of those of the Upper-furnace ; it employs more workmen than any other single mine on the island, and produces, in one season, more metal. The stratification of the excavation is very regular ; it consists, under the soil, of alternate layers of sand and clay of various colors, between which the black clay occurs in extensive irregular masses. The lowest stratum, containing the ore, had been lately carried out, and was collected in a large heap preparatory to the process of washing.

I collected at this heap a great variety of the stones which had composed the stratum, of which I shall mention only the chief, as the other varieties will be successively pointed out in the description of the mines.

* * * * * * *

[These stones are mainly quartz and feldspar, with the conglomerate and ironstone before described ; also]

Large masses of a white substance which is considered by the Chinese miners as an unequivocal indication of the termination of a stratum of ore, the name is *Kongtay*. It is of the purest white color, very light and adheres strongly to the tongue, it possesses all the properties of pure clay ; and the manner in which it is found, demonstrates plainly that it is a deposition from water. On this the ore of tin is composed in strata differing in richness and extent, and mixed with the various kinds of stone which are from time to time enumerated in the account of the mines.

The mines of Sungei Tángo, as well as those of Sungei Bulák above mentioned, have been worked for many successive years, and their neighborhood forms the most extensive naked tracts of the country in this part of the island.

Proceeding from here to *Klábbet* the road leads nearly in a western direction through a most luxuriant forest, the soil of which consists of a thick black vegetable mould.

The most important mine in this district is that of *Sinhin*, it employs thirty-two workmen, and is the second in productiveness of those at present worked in Bánká. I found the miners within six feet of the stratum of ore : they were engaged in carrying out the earth from an extensive pit of an oblong form.

On one of the sides I remarked the following succession of strata :

1. Vegetable mould.
2. Black clay in extensive masses abruptly and irregularly interposed between the other strata.
3. Fine whitish sand (with a small proportion of clay intermixed.)

On another of the sides I remarked,
1. Soil.
2. Black clay massive.
3. Sand adhering partially by means of a clayey cement.
4. Pure white sand.

The difference between the two last mentioned layers was very evident: in the third the proportion of clay was very abundant, and united the particles of pure white sand to a mass which became solid by drying. The fourth was a pure sand consisting of minute grains of quartz, most of which were transparent; in distinction from the other, it was perfectly loose without any adhesion of its particles.

The manner in which the black clay is generally interposed or intruded between the other strata deserves some attention, but will more properly be considered elsewhere.

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The mines of *Sunnie* are situated near the northern boundary of the district of the mines above mentioned. They are of the *large* kind: the workmen had, at the time of my visit, nearly arrived at the commencement of the stratum containing the ore, after having penetrated:

1. A stratum of soil, ...	2 feet.
2. White clay mixed with a small proportion of sand, becoming a solid mass by drying, . . .	3 "
3. Coarse sand, consisting chiefly of fragments of crystals of quartz in some places, intervening small masses of clay, ...	2 "
4. Black clay in irregular masses, . . .	2 "

5. Fine sand, dispersed through particles of quartz and fragments of decomposed granite rocks: here the ore commenced to be thinly disseminated through the stratum, the lowest portion of the layer which had been carried out from the last pit adjoining to the present work, had consisted of very large fragments of decomposed granite, through which the ore had been plentifully dispersed. The miners informed me that the vein of ore on which they had been employed for three years, and which occupied the lowest part of the valley, had several times intersected the course of the river which flows through it.

* * * * * * *

On my track from the mines of Sunnie to Mámpáng, I was gratified, for the first time, by the discovery of a rock of granite in its original situation, in the midst of a forest and almost concealed by a thick coat of moss. This directed my attention to the hill Gánten, with its appendages, which was near by the road. I found that the rock which forms the basis of this hill is of the same kind.

In the specimens of granite which I collected from this hill, the mica is, upon the whole, very sparingly distributed; the fragments of quartz are of very different sizes, from that of the smallest grain, to crystals nearly an inch in length; the feldspar is mixed with the other parts in large oblong or rhomboidal fragments which are mostly easily separated, and in many parts occupy the greatest proportion of the mass. In some portions minute particles of schorl are barely perceptible, in some these are uniformly mixed with the substance of the stone, in others none are to be discovered.

* * * * * * *

In all the rocks which I examined, and of which I collected specimens, the mica was, upon the whole, sparingly distributed, and the only occasional admixture was schorl in very small proportion.

The mines of Mámpáng have been opened within the last two years near a small river called *Tengalow*, which discharges itself into the ocean, a little east of Sekâ: they are situated in the granite district, about one mile from the northern shore of the island. The miners (at the mine *Sunwad*) had met the layer of ore about ten feet below the surface, it was situated in a valley, and pursued nearly the same direction as the bed of the river, which was turned from its course, and employed for the purpose of washing the ore, as an aqueduct.

I noticed the following strata:

1. Soil, ... 2½ feet.
2. A mixture of fine particles of quartz and clay, . 4 "
3. Detached coarse particles of quartz and feldspar with a small portion of clay and some sand, . 3 "
   At the bottom of this stratum the particles of tin ore become perceptible.
4. Coarse fragments of quartz and feldspar with small particles of schorl; this contained the ore of tin: at the termination the workmen produced to me the white friable substance above mentioned, called Kongtay by the Chinese.

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The mines of *Táyu* belonging to Sungie-bulu and those of *Táynám* and *Seám*, are situated at the southwest extremity of the district of the mines, at no great distance from the road. I passed along an extensive aqueduct of the mine of Táyu, which had lately been constructed. Having left the district of the mines, the road leads through a thick forest, the soil of which is a deep, black, vegetable mould. The country is on the whole descending. Besides several extensive veins consisting of fixed rocks of red ironstone, I observed fragments of this stone wherever the stratum of soil was removed by a current of water. In the stockade of Sungie-bulu were collected several large frag-

ments of sandstone, of the same color and constitution as that found at the last mine above mentioned: upon examination I found that they were brought from the foot of the hill Pári-pári, where this stone is found in abundance. I obtained by means of the natives several specimens from their natural situation. The stockade of Sungie-bulu is built in the alluvial district, the confines of which will more accurately be pointed out in future.

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In the NORTHERN DIVISION of the island of Bánká the hills are divided into two separate ranges, one near the western the other inclining towards the eastern boundary, between which an extensive space remains which is occupied by the Bay of Klábbet.

This bay has, upon the whole, the same direction as the general range of hills, from northwest (or N.N.W.) to southeast (or S.S.E.) it is terminated on the south by the mountain of Márass: in the geographical account, the northern part of the island has been divided into two peninsulas according to the division naturally formed by this bay.

The mineralogical appearances in the western range and its environs having been described, I proceed to the detail of those in the eastern. The rocks which project beyond the surface at the shores of the bay, as well as those dispersed through the entire western portion, are granite: I examined them in my course through the bay at numerous points. The constitution of the islands of Pulo-Kláppá, near the points Tánjong-Ru and Tánjong Mántung, which separate the outer from the inner bay, and which nearly meet each other from the west and from the east, is of the same kind: they are both immense piles of granite rocks, similar to those above described, on which vegetation has commenced.

The gradual inclination or meeting of the declivities of both ranges of hills towards the west from the eastern, and towards the east from the western, is evident not only by the excavation which is filled up by the bay, but also by the course and discharge of the numerous rivers from both sides, and which have been accurately enumerated in the geographical description of the island.

I had an opportunity only of examining the eastern confines of the bay. Between the projecting points or promontories of the hills, bounding the outlets of the rivers, there remains a considerable alluvial tract: and the district of the mines commences towards the sides of the hills from the boundary of the bay.

Beginning in the north near Tánjong Mántung, we meet the outlet of the river of *Pánjie* flowing into the inner bay, a small branch (but which is considerably dilated by the influx of the tide) takes a somewhat northern direction: on this the stockade of Belinyu is built, at no great distance from the promontory

which runs off from the central range and forms the point Tán-jong Mántung. Hence I proceeded in a northern direction to the district of the mines.

On leaving the stockade a long extended hill is observed towards the central parts of the peninsula, which was pointed out to me as Gunung Pánjie (or Pántjie), beyond which the highest parts of the Gunung Towing are occasionally observable stretching towards the southeast.

The road on leaving the stockade is slightly ascending, and the country soon becomes waving. About a mile north of the stockade I observed the first granite rocks: they soon became numerous on both sides of the road, and some of them were of considerable size. One in particular attracted my notice. It stood alone, the form was irregularly conical, the top tabular, and the sides, about half way down, regularly excavated by the gradual operation of the descending water after rains.

Most of these rocks, like those at Mámpáng, were porphyritic with feldspar in large parallelograms and squares. On several parts of the road I found loose rounded fragments of red ironstone, similar to those collected in the alluvial districts above mentioned, but I remarked none in situ.

The district of the mines is situated north of the stockade: they have been worked for many successive years, and extensive surfaces remain exposed.

The mine at present worked is at Towállám: the pit was regularly oblong. I noticed at different sides the following strata.

In the south,

1.	Stratum, vegetable mould, . . .	1½ feet.
2.	Black clay, massive as observed in the other mines,	8 "
3.	Clay of a grayish color containing a small proportion of sand, ...	4 "
4.	Black clay, irregular massive, . . .	6 "
5.	Coarse sand in transparent grains imbedded in pure white clay, ...	3 "

This extended to near the stratum containing the ore of tin. One of the miners with a long crowbar raised a portion of it and obtained for me some of the ore of tin: they were employed in carrying out the last mentioned stratum.

In the west,

1. Stratum, vegetable mould.—2. Black clay, massive.—3. Sand in clay of a gray color.—4. White sand.—5. Beautiful white sand (of transparent siliceous particles) and clay.—6. Sand imbedded in yellow clay.—7. Sand in dark bluish clay. The last three layers were less regularly horizontal in their disposition than the layers of sand in many other mines; they had considerable inclination.—8. Loose white sand.—9. Yellow sand, col-

ored with particles of clay, but scarcely adhering; on this followed,—10. The stratum of coarse fragments of decomposed granite, and of breccias through which the ore of tin was disseminated.

None of the mines I visited afforded me a more beautiful and distinct view of the succession of the strata, or more explanatory of their arrangement. The pit on which the workmen were employed had been formed with uncommon neatness, and by means of the abundance of the clayey particles, the sides had remained completely regular and perpendicular. The last layer (No 9 just mentioned) of yellow sand, contained delicate streaks of the ore of a black color, (consisting of very minute particles,) which became evident when it was divided by a sharp cutting instrument: these streaks were not completely regular or uniform, some were horizontal, others had a gentle inclination, they indicated the approach of the stratum which next followed, consisting of larger quantities of the ore distributed through the coarser fragments of decomposed granite rocks, which from the appearance of the stones brought up by the last works contain, or are intersected by veins of red ironstone. The stratum on which the miners were now employed was considerably extensive, spreading in all directions round the mine.

Among the substances which remained from former works near this pit I remarked:

1. Large fragments of siliceous rock of the same kind with that described above, found at the mines of Sungie-Bulak.

2. *Kongtáy* or white friable earth, remaining at the bottom of the stratum, near the termination of the tin ore.

3. *Conglomerate breccias*, these particularly attracted my notice: many of the masses had the constitution of the *red ironstone;* others were aggregate. Although I had found numerous loose fragments of the common redstone on the road to these mines, an attentive search had discovered to me none in large or fixed rocks. The fragments which were collected here, shewed plainly that the miners in taking out the stratum containing the ore, had encountered extensive veins: and they informed me that the blocks which I examined, and which were abundantly strewed over the surface, had been taken from some of the latest pits.

They differed in appearance considerably from the red ironstone found in the environs of Jebus and Klábbet. The stone was much more compact and ponderous. The fracture had mostly a metallic lustre, varying in shades of color, but without the cellulosities above mentioned.

It was generally covered with a yellow or red ochreous crust, and some portions are completely converted into a yellow or red ochre; but particles of quartz were in all instances perceived on the solid masses or in the friable portion. Some of the smaller

fragments, and those particularly taken from the aqueducts, were more purely breccias, consisting of coarse siliceous fragments united by a ferruginous cement; to many of these the ore of tin was still found adhering in very minute particles. From Belinyu to Pándjie, the country is on the whole, alluvial. I observed one granite rock projecting from a branch of the river; the stones which have been collected by the inhabitants of Pándjie for various purposes, are explanatory of those found in the neighborhood; they consisted of fragments of granite and of red ironstone. The mines of Pándjie were situated towards the hill of that name, which has been marked on the map.

That part of this peninsula which, bounding the bay in the east, stretches from the stockade and environs of Belinyu and Pándjie towards the foot of the Gunung Márass, is alluvial. The stockade of Lumut is situated in it, a considerable distance up the river of that name and near the eastern confines of this tract; in proceeding to it from the usual landing place, the road passes several elevations which here bound the alluvial plain. These consist of red ironstone in separate rocks and in large veins covering extensive surfaces. Loose fragments are also dispersed on the road. Those rocks which I examined more minutely and from which I collected specimens, were more similar to those of Jebus and Klábbet than those found at the mines of Towállám just mentioned.

They are mostly cellular, and the fracture is partly ochreous and partly metallic: the separate particles of some of them are very ponderous.

These hills formerly contained strata of ore which has been successively extracted; on approaching the stockade the remains of many of the former mines are passed. Here the surface is covered with mixed stones; fragments of granite, breccia and coarse sand, similar to those found at the aqueducts, are strewed on the sides of the road in every direction. From the stockade of Lumut the district of the mines stretches northward, inclining to the west until it meets that of Pándjie and Belinyu.

I commenced the examination of the mines of Lumut about half a mile to the north of the stockade, at one of the small mines which had lately been relinquished. The process had been carried on as usual on a slightly inclining ground. A vertical section exposed the strata of the hill, and the extensive surface below contained the remains of many former works.

On the side of the hill I noticed—

1. (Layer) soil.—2. Sand.—3. Coarse sand, consisting of large particles of quartz.—4. Clay of a reddish color.—5. Coarse sand.—6. Clay.—7. Extremity of the layer from which the ore had been extracted: the fragments which composed it were chiefly siliceous, of the mixed kind above described, consisting nearly of equal proportions of quartz and feldspar combined into a variegated mass.

The succession of strata was very distinctly exhibited in this mine; the lowest was peculiarly characteristic; and afforded me an opportunity of observing a vertical section of the stratum containing the ore in its natural situation; the fragments which composed it could be separately removed; they were of different sizes, from less than an inch to several inches in diameter.

Although it was evident that they consisted of portions of the decomposed or disseminated primitive rocks of the surrounding districts, their present arrangement shewed that they had undergone a revolution, and had been removed out of their natural situation. A considerable proportion of the feldspar was in a state of decomposition, and appeared as a clayey substance; to these the particles of tin ore often adhered. Grains of sand were mixed, but in comparatively small quantity, with the coarse fragments which formed the stratum.

The surface which had been exposed by the successive works of this mine was very extensive; they had been commenced in a low situation, and the productiveness of the stratum had gradually diminished as the acclivity of the hill increased; the miners, supposing it to be near its termination, had given up the work. The stones which remained here resembled those usually found at the aqueducts. The abundance and size of the fragments of red ironstone and pudding-stones shewed here, as at Towállám, that the miners had met with extensive veins of this stone.

The next mine is situated two miles further north; from the chief miner who administers the work, it is called Hopsun. On the road to it, I passed extensive districts which had formerly been worked. Large fragments of ironstone and pudding-stones were abundantly dispersed over this tract; they were mostly detached and had been removed from their natural situation by the process of mining, and by the formation of canals. The veins from which they were taken, had in many instances run near the surface. In this mine I noticed the following strata:

1. Soil.—2. Sand imbedded in clay of a gray color.—3. Black clay.—4. Coarse white sand.

The stones at the aqueducts were fragments of the common siliceous kind, large and mostly of a white color; very few breccias were mixed with them.

In the next mine called Lakuntouw, situated about half a mile east northeast of the last mentioned, I found the strata—

1. Soil.—2. Sand imbedded in whitish clay.—3. Sand in dark colored clay.—4. Sand in beds of variegated colors.—5. Black clay.—6. White sand.

The stones at the aqueducts resembled those found at the last mine; they contained comparatively few conglomerates or breccias; those which occurred resembled those of the mine of Belinyu.

They were ponderous; siliceous particles appeared on the fracture, alternating with portions of a metallic lustre, and the surface was ochreous. A few consisted of minute particles approaching the nature of sandstone.

The mineralogical appearances in the two districts last described, were very similar to those of the western peninsula of this division of the island. This similarity was displayed, not only in the arrangement of the strata, but particularly in their relative proximity to the surface; it likewise appeared in the constitution of the more fixed parts of the island. Various circumstances did not permit me, in this part of the island, to extend my researches to the range of central hills; but the promontories which descend from them towards the west and form Tánjong Mántung, (which I passed in proceeding to the mines of Belinyu,) as well as extensive districts in the neighborhood, are covered with large piles of granite rocks. Numerous veins of red ironstone have been discovered below the surface at the mines of Belinyu, and in the vicinity of Lumut we met extensive hills, composed of them, and which are in immediate conjunction with the alluvial plains above mentioned, bounding the Bay of Klábbet.

The northern portion of this peninsula up to point Tánjong Tádá is completely unknown; nor can I say any thing from personal observation of that tract which bounds the central range of hill on the east, extending from point Tánjong Tuwing to the confines of Sungie-liat; but the information I obtained from various natives at Belinyu and Lumut, tends to shew that many portions of it are stratified like the districts of the mines on the west side of the range of hills; and from trials made during my residence at Bánká, it appeared that these strata contain a sufficient quantity of the ore of tin to encourage an attempt for extracting it. The district of Mápur is in this situation, and it is followed in the south by that of Dsheniáng, in which mines are at present worked that are under the superintendence of Sungieliát. As to the districts of Belinyu and Lumut, it is proved by the daily trials at present instituted to obtain productive situations, that the richest strata have been exhausted in the course of forty years successive mining.

(To be continued.)

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *An Inquiry into the Amount of Inorganic Constituents contained in Ale and Porter;* by Thomas Dickson, Manchester, late Assistant in the University Laboratory, Edinburgh, (Phil. Mag., Nov., 1848, vol. xxxiii, p. 341.)—The object in view in commencing the series of analyses given below, was to ascertain if a standard could be formed of the nutritive powers of the ales and porters in general use, in order that a correct estimate of their real value as an article of diet might be deduced.

The analyses show, as might have been expected, a very great variety in the amount of their respective constituents, partly arising from the various modifications each brewer finds himself under the necessity of adopting, from local circumstances over which he has no control, or from personal experience, though the main steps of the process are essentially the same throughout.

The ash consists of that portion of the grain, and other substances employed in the process, which is soluble in water; whilst owing to the various proportions of malt and water employed, to the length of time the infusion is continued, to the temperature at which the infusion is made, to the concentration the liquor undergoes in the boiling to which it is subsequently subjected, and to the process of fermentation, the proportional amount of the constituents varies considerably.

The method given by Fresenius and Will for the analysis of ash was that followed in the present instance. The amount of iron has been omitted, as in most of the cases it was altogether wanting; and in the few instances in which it did occur, it was so minute as to be inappreciable, and apparently was only an accidental impurity.

In order to save needless repetition, the analyses have been calculated after the deduction of the carbon and moisture, and are as follows:—

No. I. Scotch ale at 3*s.* per gallon.

Potash	24·547
Soda	31·429
Lime	1·203
Magnesia	0·399
Chlorine	5·095
Sulphuric acid	2·131
Phosphoric acid	25·657
Silica	6·539
	100·000

No. II. Another variety of Scotch ale at 3*s.* per gallon.

Potash	26·603
Soda	35·715
Lime	0·555
Magnesia	0·232
Chlorine	9·754
Sulphuric acid	2·272
Phosphoric acid	20·005
Silica	4·864
	100·000

No. III. Another variety of Scotch ale at 3*s.* per gallon.

Potash	20·925
Soda	53·083
Lime	0·172
Magnesia . . .	0·331
Chlorine . . .	4·283
Sulphuric acid . .	1·615
Phosphoric acid . .	12·513
Silica	7·078
	100·000

No. IV. Scotch ale at 2*s.* 6*d.* per gallon.

Potash	22·119
Soda	33·180
Lime	0·862
Magnesia . . .	4·642
Chlorine . . .	6·925
Sulphuric acid . .	3·214
Phosphoric acid . .	24·172
Silica	4·586
	100·000

No. V. Another variety of Scotch ale at 2*s.* 6*d.* per gallon.

Potash	15·913
Soda	42·758
Lime	0·707
Magnesia . . .	0·963
Chlorine . . .	10·085
Sulphuric acid . .	4·657
Phosphoric acid . .	16·346
Silica	8·571
	100·000

No. VI. Scotch ale at 2*s.* per gallon.

Potash	23·710
Soda	46·085
Lime	1·979
Magnesia . . .	5·650
Chlorine . . .	3·652
Sulphuric acid . .	0·130
Phosphoric acid . .	12·049
Silica	7·345
	100·000

No. VII. Another variety at 2*s.* per gallon.

Potash	10·484
Soda	48·394
Lime	0·257
Magnesia . . .	2·269
Chlorine . . .	6·649
Sulphuric acid . .	5·562
Phosphoric acid . .	15·333
Silica	11·052
	100·000

No. VIII. Scotch ale at 1*s.* 9*d.* per gallon.

Potash	27·564
Soda	40·520
Lime	1·341
Magnesia . . .	1·633
Chlorine . . .	8·121
Sulphuric acid . .	7·014
Phosphoric acid . .	7·923
Silica	5·884
	100·000

No. IX. Scotch ale at 1*s.* 6*d.* per gallon.

Potash	3·162
Soda	58·508
Lime	0·874
Magnesia . . .	1·032
Chlorine . . .	6·450
Sulphuric acid . .	6·277
Phosphoric acid . .	17·622
Silica	6·075
	100·000

No. X. Another variety at 1*s.* 6*d.* per gallon.

Potash	29·828
Soda	38·390
Lime	0·740
Magnesia . . .	0·505
Chlorine . . .	5·557
Sulphuric acid . .	2·773
Phosphoric acid . .	16·827
Silica	5·380
	100·000

No. XI. Scotch ale at 1*s.* 3*d.* per gallon.

Potash	31·907
Soda	20·871
Lime	6·694
Magnesia	1·558
Chlorine	9·454
Sulphuric acid	2·665
Phosphoric acid	16·851
Silica	10·000
	100·000

No. XII. Scotch ale at 1*s.* per gallon.

Potash	17·570
Soda	31·285
Lime	1·536
Magnesia	2·163
Chlorine	8·802
Sulphuric acid	7·072
Phosphoric acid	16·657
Silica	14·915
	100·000

No. XIII. Another variety at 1*s.* per gallon.

Potash	11·635
Soda	24·862
Lime	0·646
Magnesia	0·064
Chlorine	18·255
Sulphuric acid	14·566
Phosphoric acid	10·925
Silica	19·047
	100·000

No. XIV. Export ale at 3*s.* per gallon.

Potash	19·418
Soda	37·131
Lime	1·242
Magnesia	0·528
Chlorine	6·559
Sulphuric acid	19·160
Phosphoric acid	5·984
Silica	9·978
	100·000

No. XV. London porter at 3*s.* per gallon.

Potash	26·357
Soda	21·777
Lime	6·893
Magnesia	0·394
Chlorine	9·133
Sulphuric acid	6·615
Phosphoric acid	20·576
Silica	8·255
	100·000

No. XVI. Another variety at 3*s.* per gallon.

Potash	31·140
Soda	32·933
Lime	1·514
Magnesia	0·122
Chlorine	6·459
Sulphuric acid	4·637
Phosphoric acid	9·261
Silica	13·934
	100·000

No. XVII. London porter at 2*s.* 6*d.* per gallon.

Potash	11·938
Soda	24·330
Lime	3·868
Magnesia	0·659
Chlorine	14·528
Sulphuric acid	12·198
Phosphoric acid	19·545
Silica	12·934
	100·000

No. XVIII. Dublin porter at 2*s.* 6*d.* per gallon.

Potash	32·042
Soda	42·722
Lime	1·543
Magnesia	0·512
Chlorine	6·777
Sulphuric acid	1·574
Phosphoric acid	7·893
Silica	6·937
	100·000

No. XIX. Scotch porter at 2*s*. per gallon.	
Potash	20·883
Soda	38·766
Lime	1·623
Magnesia	0·166
Chlorine	0·151
Sulphuric acid	6·358
Phosphoric acid	18·773
Silica	13·280
	100·000

No. XX. London porter at 2*s*. per gallon.	
Potash	16·032
Soda	50·820
Lime	1·306
Magnesia	0·097
Chlorine	7·420
Sulphuric acid	4·526
Phosphoric acid	10·279
Silica	9·520
	100·000

No. XXI. Another variety at 2*s*. per gallon.	
Potash	22·879
Soda	30·521
Lime	1·335
Magnesia	1·272
Chlorine	10·919
Sulph'c acid	4·973
Phosph'c acid	12·859
Silica	15·242
	100·000

No. XXII. Dublin porter at 2*s*. per gallon.	
Potash	21·382
Soda	24·008
Lime	0·833
Magnesia	1·187
Chlorine	10·097
Sulph'c acid	2·763
Phosph'c acid	19·987
Silica	19·743
	100·000

No. XXIII. Scotch porter at 1*s*. per gallon.	
Potash	18·861
Soda	33·765
Lime	1·344
Magnesia	1·386
Chlorine	11·386
Sulph'c acid	2·177
Phosph'c acid	12·480
Silica	18·601
	100·000

The dried residue of No. I. yielded 4·800 per cent. of ash.

"	"	II.	"	3·395 "
"	"	III.	"	3·797 "
"	"	IV.	"	5·475 "
"	"	V.	"	3·500 "
"	"	VI.	"	4·621 "
"	"	VII.	"	3·595 "
"	"	VIII.	"	4·673 "
"	"	IX.	"	4·152 "
"	"	X.	"	3·885 "
"	"	XI.	"	8·186 "
"	"	XII.	"	7·626 "
"	"	XIII.	"	12·035 "
"	"	XIV.	"	8·666 "
"	"	XV.	"	7·863 "
"	"	XVI.	"	8·822 "
"	"	XVII.	"	6·864 "
"	"	XVIII.	"	5·720 "
"	"	XIX.	"	6·050 "
"	"	XX.	"	9·001 "
"	"	XXI.	"	14·579 "
"	"	XXII.	"	11·113 "
"	"	XXIII.	"	6·054 "

2. *On a New Method for the Detection of Bromine and Iodine;* by Dr. G. L. CANTU, (Chem. Gazette, Oct. 1st, 1848.)—The water to be examined is evaporated to a small bulk; pure carbonate of potash (the absence of bromids and iodids in which, has been ensured by washing repeatedly with alcohol) is then added in slight excess to precipitate earthy salts which may be present. After boiling for some time, the liquid is filtered and evaporated to dryness; the residue is now powdered and digested in alcohol, sp. gr. ·830, which dissolves any bromids or iodids that may be present. The alcoholic solution is evaporated to dryness, and gently ignited to destroy the organic matter which is generally present; a few drops of dilute acetic acid are now added so as to be in slight excess, taking care to neutralize a trace of carbonate of potash taken up by the alcohol. It is now again evaporated to dryness, care being taken not to heat it so much as to decompose the acetate. The residue is finally dissolved in a very little water and mixed with two or three drops of a weak solution of starch recently prepared. This being done, a small portion of the test-liquid which consists of a mixture of ten parts of sulphuric acid of 66° (sp. gr. 1·767), and one of nitric acid of 25° (sp. gr. 1·197), is placed in a glass with a narrow base; the solution of the saline residue is then poured very gently down the side, so as to rest upon the test-liquid without mixing with it. If iodids or bromids existed in the water, and their coëxistence is almost constant, there will quickly appear two zones in the saline solution, one of a clear topaz-yellow sometimes inclining to green, (bromine,) and the other of a blue color, (iodine,) floating above it.

[I have had occasion to employ this test in the qualitative examination of mineral waters, and believe that it leaves nothing more to be desired in testing for bromine and iodine. I may remark in passing, that having had occasion to analyze minutely a great number of saline waters in this country, I have scarcely ever failed to detect these two elements, although the amount of iodine, always small in proportion to the bromine, is often exceedingly minute.] T. S. HUNT.

3. *Researches on the Compounds of Titanium;* by G. M. EBELMAN, (Ann. de Chem. et de Phys., xx, p. 385.)—By passing a mixture of pure hydrogen gas and the vapor of the perchlorid of titanium, through a glass or porcelain tube heated to redness, a new compound was deposited in large dark violet-colored shining scales, much less volatile than the perchlorid, a portion of which undecomposed is deposited in the colder portions of the tube. It is readily decomposed when heated in the air, into oxyd of titanium (titanic acid) and perchlorid. It is deliquescent and yields, with water, a violet-red solution, which when evaporated, evolves hydrochloric acid, and leaves a blue oxychlorid. Ammonia gives in the solution a dark-brown precipitate, which is undoubtedly the sesqui-oxyd; by exposure to the air it becomes black, then blue, and finally white; if air is excluded, hydrogen gas is evolved from the decomposition of the water, and the same changes in color take place. The formation of the blue compound by the decomposition of water shows it to be intermediate between the sesqui- and per-oxyd, (perhaps $Ti_3 O_4$ analogous to magnetic oxyd of iron.) The analysis of the violet chlorid showed its composition to be $Ti_2 Cl_3$. Its solution reduces salts of gold, silver and mercury to the metallic state, and converts the persalts of iron into protosalts, titanic acid being formed.

In the above process, there was besides formed in the tube, metallic titanium, (in greater quantity as the heat was more intense,) and a minute portion of what appeared to be proto-chlorid.

By heating pure titanic acid in a current of perfectly dry hydrogen gas, it experiences a loss in weight equal to half an equivalent of oxygen, and is converted into $Ti_2 O_3$. This oxyd is slowly rendered white by roasting in the air; it is not attacked by any acid but the sulphuric, which dissolves it into a violet liquid. The process for the analysis of titanic iron by heating it in a current of hydrogen, which depended upon the supposition that titanic acid was not deoxydized by the gas, is consequently inaccurate.

By dissolving the sesqui-chlorid in sulphuric acid, a violet red solution was obtained, which evaporated *in vacuo* over lime, gave indistinct crystalline masses of a sesqui-sulphate; the solution reacts like the sesqui-chlorid.

The sulphuret found by Rose, by passing the vapor of bisulphuret of carbon over $Ti O_2$, gave results on analysis approximating to a formula $Ti_2 S_3$, (Ti = 314·7 Pierre.) By passing sulphuretted hydrogen through the perchlorid heated in a retort nearly to boiling, and transmitting the vapors through a tube, heated to faint redness, hydrochloric acid was evolved and a pure bisulphuret was deposited in soft brass-yellow crystalline scales, with a metallic lustre and resembling *aurum musivum*. By exposure to the air it is slowly decomposed with the evolution of sulphuretted hydrogen. The reaction with sulphuretted hydrogen begins below the boiling point of the chlorid, for the sulphuret is in part precipitated as a greenish substance in the bottom of the retort. T. S. H.

4. *On some Volatile Products resulting from the decomposition of Albumen, Fibrine, Caseine and Gelatine, by oxydizing agents;* by Dr. G. Guckelberger, (Chem. Gazette, March 1st and 15th, 1848, from Liebig's Annalen, lxiv, p. 39.)—The admirable researches of Schlieper* on the oxydation of gelatine by chromic acid, led to the hope that the examination of analogous azotized animal substances would afford important results, and with this view the author has submitted those above named to the action of a mixture of oxyd of manganese and sulphuric acid, as well as to the mixture of bichromate of potash and sulphuric acid. His researches have shown the entire correctness of Schlieper's researches, and have moreover afforded many new and important results.

Caseine with oxyd of manganese and sulphuric acid, has given him acetic aldehyde, metacetonic aldehyde, (?) butyric aldehyde, bitter almond oil, formic, acetic, metacetonic, butyric, valerianic, caproic and benzoic acids. With chromic acid, the products were metacetonic aldehyde, (?) bitter-almond oil, and formic acid in small quantities; metacetonic, butyric, valerianic, benzoic and prussic acids, besides the valeronitrile of Schlieper,† and a heavy oil with the odor of cinnamon.

The caseine was purified by solution in carbonate of soda and precipitation by sulphuric acid; it was then dried. One part of this was added to a mixture of 4½ parts of concentrated sulphuric acid, with

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* This Journal, vol. v, p. 118. † Ibid.

twice its weight of water cooled down to 104° to 120°. After standing a day to allow the fat to separate, it was mixed with three parts of manganese and thirty of water, and submitted to distillation.

With chromic acid, the best proportions are three of sulphuric acid, two of bichromate of potash, and thirty of water; the caseine is dissolved as before in the acid, and afterwards mixed with the salt dissolved in ten parts of water; the action immediately commences with violence, but is moderated by adding the remainder of the water, and the distillation goes on calmly.

The separation of these bodies was effected by saturating the acids with carbonate of soda and distilling over the neutral products, which were afterwards separated by careful fractional distillation. The salts were decomposed, and the acids first separated by fractional distillation, and afterwards by crystallization of their salts.

The existence of all the acids above named, was proved by careful analysis.

The butyric aldehyde $C_8H_8O_2$, is sparingly soluble in water; it boils at 154°–158° F., and has a specific gravity of ·800 at 59°. It tastes like acetic aldehyde, but soon becomes acid on exposure to the air from the formation of butyric acid; it reduces oxyd of silver when boiled with it, and forms a butyrate; with a solution of nitrate of silver and ammonia, it gives a metallic mirror. It reacts like acetic aldehyde with potash and ammonia, giving with the latter a crystalline compound closely resembling in its properties aldehyde-ammonia. With sulphuretted hydrogen, it yields a base resembling thialdine.

The characters given by the author differ somewhat from those ascribed by Chancel to the butyral obtained by the distillation of butyrate of lime, which he regarded as the aldehyde of butyric acid.

[It is to be observed that the aldehyde of Dr. Guckelberger approaches nearly in its boiling point to that found by calculation, 145°·2 F., while Mr. Chancel found the boiling point of his liquid to be 203° F.]

The supposed metacetonic aldehyde could not be obtained pure; a liquid of an ethereal odor, boiling between 130° and 149° F., gave numbers closely agreeing with the formula $C_6H_6O_2$. Its specific gravity was 0·79, at 59° F.; it became acid by the action of the air, but did not reduce a solution of silver. From the small quantity of it, the author was unable to make a more minute examination.

The products by chromic acid differ from those obtained by the action of sulphuric acid and manganese, in containing valeronitrile and prussic acid, which are azotized substances. Their absence in the former is explained by the fact that these are at once decomposed by an excess of sulphuric acid, into valerianic and formic acids and ammonia. The residue from the process with manganese evolves a great amount of ammonia with lime, while that from chromic acid yields scarcely a trace.

The fibrine and albumen employed were obtained from blood; these substances and gelatine were treated in the same manner as caseine. With manganese and sulphuric acid they all gave the same aldehydes and acids as caseine, without a trace of prussic acid; the relative proportions of these however varied; with chromic acid, the distillates were all rich in prussic acid, and afforded valeronitrile, besides all the

various products obtained from the caseine. There is then, a perfect similarity between the products of the oxydation of all these bodies; the author observed that the amount of volatile products was increased when the organic substances were allowed to digest for some time with the sulphuric acid, which shows that the acid acts by breaking up the compound into different organic groups.

The author observes that he has obtained acetic aldehyde by treating milk-sugar with chromic acid, and that Engelhardt has observed it in the distillation of lactate of copper.

[These researches show an identity between the products of the decomposition of gelatine and the so-called proteine bodies by oxydizing agents; to which is to be added the fact that both of them afford leucine by alkalies and acids, and according to Berzelius, both yield malic (saccharic?) acids, by the action of nitric acid. The difficulties presented in determining the composition of these substances by direct analysis are very great, from the absence of any test of their purity; from their constant tendency to decomposition rendering it impossible to boil them in water, or even dry them without change, and from the presence of variable and often considerable portions of sulphur and phosphorus, which are only in part separated by the action of alkalies. The immense number of analyses performed, and researches which have been made, and the various disputes upon the subject which have vexed the chemical world, have left us no wiser than before.

In a late communication,* I attempted to show that gelatine may be regarded as an azotized derivation of cellulose, dextrine or some isomeric body, and that a formula agreeing at once with the results of its decomposition and the various analyses, is $C_{24}H_{20}N_4O_8 = C_{24}H_{20}O_{20} + 4NH_3 - 12HO$.†

The complete similarity between the decomposition of gelatine and the proteine bodies by deoxydizing agents, suggests the idea that the latter are likewise derivatives of cellulose. The sulphur and phosphorus so variable in their proportions as they are found to be, can scarcely be regarded as Mulder has represented them, elements bearing an equivalent ratio to the oxygen, carbon, hydrogen and nitrogen, while the affinity by which they are retained, tends to show that they still make an integral part of the combination. They are, it appears to me, to be viewed as replacing in part the oxygen and azote of the normal compounds in the same way as minute portions of magnesium or strontium may replace the calcium in calcite and arragonite, or arsenic the phosphorus in pyromorphite. In calculating formulas from analyses, 16 parts of sulphur should then be regarded as equivalent to 8 of oxygen, and 31·7 of phosphorus to 14 of azote. Supposing the normal compound to be equal to one equivalent of cellulose, with three of ammonia minus twelve of water, we have the formula $C_{24}H_{17}N_3O_8$ ($= C_{24}H_{20}O_{20} + 3NH_3 = C_{24}H_{17}N_3O_8 + 12HO$.‡ The results obtained

* See this Journal, Jan., 1848, p. 70. † Ibid.

‡ The formula of cellulose, sugar, and all the allied compounds, must evidently be regarded then, as C_{24}, &c., if we take the equivalent of hydrogen as 12·5, oxygen being 100; these compounds are well known to be polybasic. The formation of an amide by the elimination of 4HO for one equivalent of ammonia, is analogous to the reaction by which the nitrites are derived from monobasic ammoniacal salt or cyanogen from oxalate of ammonia, constituting the anhydrid amids of M. Gerhardt.

by calculation from this and from Mulder's formula $C_{40}H_{31}N_5O_{12}$, are subjoined.

	Mulder's formula.	Proposed formula.
C	54·92	53·93
H	7·09	6·36
N	16·02	15·73
O	21·96	24·34
	99·99	100·36

The following are some analyses of proteine, albumen and fibrine from different sources. I, Proteine from albumen. II, Albumen, (Mulder.*) III. and IV, Proteine, (Fleitmann.†) V. and VI, Albumen from the flesh-fluid of fowls, (Wiedenbusch.‡) VII, Fibrine, (Mulder.§)

	I.		II.		III.		IV.
C		53·7		53·6		54·1	53·8
H		6·9		7·0		7·13	7·3
N		14·4		15·7		15·94	16·24
O	23·6	24·3	22·3	23·0	21·41	22·12	21·23	21·94
S	1·4		1·4		1·42		1·43	
		99·3		99·3		99·39		99·28

	V.		VI.		VII.
C		53·05		53·31	52·7
H		7·10		6·96	6·9
N		15·82		15·69	15·1
O	22·29	23·06	22·28	23·07	23·5	24·1
S	1·55		1·57		1·2	
Ash		·19		·19	Ph	·03
		99·22		99·22		99·13

On comparing these different numbers with each other and with the results of calculation, it will be seen that the proportions vary considerably; these differences show the liability of the substances to change, and also the frequent mixture of a body which seems to be like a fat in composition, containing no azote and little oxygen, while it is richer than proteine in hydrogen, and is perhaps a result of the alteration of the proteine itself. In Mulder's formula the carbon is from one to two per cent. above that yielded by the analyses, while the oxygen falls nearly as much below that obtained in several instances. This is seen still more strikingly if we regard the sulphur as metaleptic of oxygen in the compound, as I have represented it in the formulas. The first and seventh analyses correspond much more closely to my proposed formula, and this in the case of fibrine, is more clearly seen when we correct that for 100 parts, making it C 53·15 O 23·72, which with ·6 corresponding to 1·2 of sulphur, gives O 24·32.

The reaction of proteine with strong hydrochloric acid by which it is resolved into ammonia and humic acid, a product identical with that derived by the action of the same acid from sugar, is explained by

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* Chem. Gazette, No. 115, p. 304.
† Ann. der Chem. und Pharm., t. lxi, p. 121.
‡ Ibid, t. lxi, p. 371.
§ This Journal, ii ser., vol. iv, p. 402.

Mulder by supposing the intervention of four equivalents of oxygen; but bodies like the fibrine of VII, and the proteine of I, obviously require no oxygen, but are converted into these products by the simple diamorphosis, or rather we may suppose into glucose or some analogous substance, and ammonia, by the assimilation of 12HO, the former of which is decomposed into humic acid and water, as is the case when a solution of sugar is treated with hydrochloric acid. I am not aware whether the absorption of oxygen in this reaction, has been determined by experiment, but if such is the case beyond that required for the oxydation of the small quantities of sulphur and phosphorus, the humus body cannot contain equal equivalents of hydrogen and carbon, unless formic acid or some more highly oxydized product is formed at the same time. This reasoning is based particularly upon the two analyses of Mulder quoted, which differ somewhat, it is true, from many others given, but the last being that of undissolved fibrine, seems more worthy of reliance than those derived from partially altered products.

If we receive then, $C_{24}H_{17}N_3O_8$ as agreeing best with analysis and as the true formula for proteine, we have at once explained the fact of this metamorphosis by hydrochloric acid, which refers it directly to the same place in the organic scale as cellulose and sugar, (for there appears no evidence that the various derivatives of sugar described as ulmine, sachulmine and humic acid, stand higher in the scale than sugar, 24th family,) while its connection with gelatine in constitution, and the perfect similarity between the products of its oxydation and those of gelatine, related by the formation of aldehyde to sugar, complete the chain of resemblances.

The assimilation of proteine seems to be different from that of gelatine, at least we have no evidence that it is ever resolved into a non-azotized compound and ammonia in the system, which the case of diabetes recorded in this Journal, ii ser., vol. vi, p. 259, seems to establish in regard to gelatine. The view which makes the tissues of the animal body but azotized derivatives of those which composed the vegetable structure, shows most beautifully the simplicity and unity of the plan of nature. T. S. H.]

5. *Phosphorus*, (L'Institut, No. 773.)—M. Schrötter, has ascertained that the red substance formed on the surface of phosphorus exposed to the light, is simply an isomeric transformation of phosphorus. It is produced in the gases hydrogen, nitrogen and carbonic acid gas, when the phosphorus is thoroughly dry; and it is therefore impossible to attribute the change to an oxydation of the phosphorus. The transformation is quite active in a direct light, and it is sensible even with a feeble diffuse light. When phosphorus, before carefully dried, is kept for 40 to 60 hours at a temperature between 240° C. and 250° C., it is transformed in part into phosphorus of carmine red color, which falls as an opaque powder to the bottom of the vessel; and with small pieces in a close vessel, after a prolonged trial, the whole may be changed to the red state. The specific gravity of this amorphous phosphorus when pure, is 1·964 at 10° C., while ordinary phosphorus is 1·840 at 10° C., or if melted 1·88, at 45° C.

The amorphous phosphorus is obtained pure by means of the sulphuret of carbon, which dissolves readily the ordinary phosphorus. It

is unalterable in the air, insoluble in ether, alcohol, naphtha, and chlorid of phosphorus. Spirits turpentine dissolves it slightly at an elevated temperature. It is much less combustible than ordinary phosphorus, and takes fire in the air at 260° C., which is the temperature at which it passes to the state of phosphorus when heated in an inert gas. A solution of boiling potash attacks it, with a disengagement of phosphuretted hydrogen not spontaneously inflammable; but at the same time the phosphorus passes to the black condition indicated by Thenard. According to M. Schrötter, phosphorus will pass to the black modification only after first having assumed the red.

6. *Observations on Manna;* by J. STETTNER, (Chemical Gazette, July, 1848, No. 137, p. 261; Archiv. der Pharm., vol. liii, p. 194.)—The author gives the following account of the cultivation of the manna ash and the collection of the manna, from observations made in Sicily during the summer of 1847. The manna ash, *Fraxinus ornus*, in the manna districts of Capace, Cinesi and Fabarotto, where the best manna is obtained, does not form woods, as is generally supposed, but is cultivated in separate plantations. These plantations generally form regular squares, hedged in with *Cactus opuntia.* The trees are planted in rows, and are from 2 to 8 inches in diameter, with stems from 10 to 25 feet high, which from the first shoot are kept smooth and clean. The soil is carefully loosened and kept free from weeds. After the eighth year the trees yield manna, which they then continue to do from ten to twelve years, when they are cut down, and young shoots from the roots trained; one root-stock frequently yields from six to eight new trees and more. For the production of the manna, young and strong shoots are requisite; but they are not tapped before the tree ceases to push forth any more leaves, and the sap consequently collects in the stem. This period is recognized by the cultivators from the appearance of the leaves; sometimes it occurs earlier than at others, and the collection of the manna takes place either at the beginning of July or only in August. Close to the soil cross sections are made in the stem, and in the lowermost sections small leaves are inserted, which conduct the sap into a receptacle formed by a cactus leaf; this is the way the manna *in sorte* is obtained. The incisions are repeated daily in dry weather, and the longer this continues the more manna is obtained. The stems are left uninjured on one side, so that the manna runs down the smooth bark more easily. The next year the uninjured side is cut. The *Manna cannelata* is obtained from the upper incisions, more than forty of which may be counted on one tree. The sap is there not so fat as below, and consequently dries more easily into tubes and flat pieces. After the manna has been removed from the trees, it has further to be dried upon shelves before being packed in cases. The masses left adhering to the stems after removing the inserted leaves are scraped off, and constitute the *Manna cannelata in fragmentis. Cannelata, Can. in fragm.* and *Capace* are collected at the same time from one stem—the more *Cannelata*, the younger, and the more *Capace* or *Gerace*, the older the stem. In Sicily the latter is designated *in sorte*, and is probably the most active. Dry and warm weather is essentially requisite for a good harvest.

II. Mineralogy and Geology.

1. *Analysis of Ehlite*; by R. Rhodius, (Wöhl. and Liebig's Annal., lxii, 372.)—Ehlite is found by R. Rhodius to consist of oxyd of copper 63·1, phosphoric acid 28·9, water 7·3=99·3. It is blackish olive green in color, and has an uneven fracture. Specific gravity 4·27. It occurs at *Ehl* near Linz on the Rhine, associated with quartz and chalcedony. The composition proves its identity with Libethenite as heretofore supposed.

2. *Analysis of Brandisite*; by von Kobell, (Leonhard und Bronn, Neues Jahrbuch, 1848, p. 217.)—Consists of silica 20·00, alumina 43·22, peroxyd of iron 3·60, magnesia 25·01, lime 1·00, potash 0·57, water 3·60, oxyd of copper and manganese, *a trace*.

3. *On Völknerite, a new Mineral;* by M. Hermann, (Erdm. und March. Jour., xl, 12; Leonh. und Bronn, Neues Jahrb., 1847, 818.)—Völknerite comes from a talcose slate in the district of Slatoust in Siberia, and was named in honor of Captain Völkner. It occurs in 6-sided tabular crystals, with a very perfect basal cleavage, white color, pearly luster, greasy feel, with the specific gravity 2·04. In the forceps before the blowpipe it swells up somewhat, but does not melt; with cobalt it affords a rose-red color. With the fluxes it fuses with effervescence to a colorless glass. *Composition*, alumina 17·75, magnesia 38·59, water 43·76; giving the formula $Mg^6 \ddot{A}l + 15\dot{H}$.

4. *Ceramohalite*; J. Jurasky, (Ost. Blätter für Lit., 1847, No 109, p. 434; Leonh. und Bronn, Neues Jahrb., 1847, 818.)—Ceramohalite occurs in thick druses with iron-vitriol near Königsberg in Hungary. It is in 6-sided tables, affording angles according to Haidinger of 92° and 134°, and belongs to the monoclinate system. It is very soluble, has an acid reaction, and an astringent taste. When heated, it deliquesces, gives out water and becomes finally a porous mass which is easily soluble in heated water, though difficultly so in cold. *Composition*, alumina 14·30, protoxyd of iron 2·15, sulphuric acid 36·75, water 44·60, insoluble residue 2·01=99·81, leading to the formula $\ddot{A}l \ddot{S}^3 + 18\dot{H}$.

5. *Feldspar in the "Orbicular Diorite" of Corsica;* by M. Delesse.—The orbicular diorite is a granitoid rock consisting of feldspar and hornblende and occurring in concentric aggregations. The feldspar is translucent and white, with a grayish or bluish shade. Specific gravity 2·737. Its crystals are like those of common feldspar or albite; yet is generally in thin crystalline lamina. It is easily attacked by hydrochloric acid, which decomposes it completely, the silica separating as a powder. *Composition*, according to the analysis of Delesse, silica 48·62, alumina 34·66, protoxyd of iron 0·66, lime 12·02, magnesia 0·33, soda 2·55, potassa 1·06, water 0·49=100·39. This gives the formula $3\dot{R}\,\ddot{S}i + \ddot{R}_3\,\ddot{S}i$. It is a variety of Vosgite, containing however three times as much lime and much less alkali, with a specific gravity about 0·04 less.

6. *On the Products of Eruption at Hecla;* by Dr. F. A. Genth of Marbury.—The substances from Hecla examined by Dr. Genth were received by him from Prof. Bunsen. The following are the results of some of his analyses.

Lava of Thjorsá.—This lava has a grayish black color and contains chrysolite along with a new feldspathic mineral which Dr. Genth calls *Thjorsauite.* The lava in its mixed state afforded—Silica 49·60, aluminas 16·89, protoxyd of iron 11·92, *trace* of protoxyds of manganese, cobalt and nickel, magnesia 7·56, lime 13·07, soda 1·24, potash 0·20=100·48.

The Thjorsauite afforded silica 48·36, alumina 30·59, peroxyd of iron 1·37, magnesia 0·97, protoxyd of manganese *trace*, lime 17·16, soda 1·13, potash 0·62=100·20, giving the formula $2\dot{R}_3\dddot{S}i_2 + 5\ddot{A}l\dddot{S}i$. It is supposed to be monoclinate in crystallization like common feldspar, and has a distinct cleavage in one direction. Lustre vitreous, but pearly on a cleavage face. Color white to grayish. Transparent. Specific gravity at 17°, 2·688. Hardness=6. Before the blowpipe in thin splinters it melts to a glass. Dissolves in borax. Insoluble in hydrochloric acid. In composition it is near scapolite whose formula is $2\dot{R}_3\dddot{S}i_2 + 4\ddot{A}l\dddot{S}i$. The chrysolite of the lava has the specific gravity 3·226.

The Lava of Háls.—This lava has a grayish black color, with an imperfectly crystalline texture. Specific gravity at 5° C.=2·919. H.=5·5–6. Slightly magnetic. Analysis gave silica 55·92, alumina 15·08, protoxyd of iron 15·18, protoxyd of manganese *a trace*, magnesia 4·21, lime 6·51, soda 2·51, potash 0·95=100·39. Dr. Genth deduces the approximate formula $\dot{R}_3\dddot{S}i_2 + \ddot{A}l\dddot{S}i_2$. It is however a rock consisting of two or more distinct minerals.

Among the other rocks described in this memoir, the lava of 1845 afforded the same formula of composition as the preceding.

The ashes of 1845 afforded silica 56·89, alumina 14·18, protoxyd of iron 13·35, protoxyd of manganese 0·54, magnesia 4·05, lime 6·23, soda 2·35, potash 2·64, which is nearly identical with the lava.

7. *On the Nummulite Limestone of Alabama;* by C. Lyell, (Proc. Geol. Soc., Jan. 9, 1847.*)—Mr. Lyell after stating that the so-called Nummulites Mantelli of Morton was distinguished by Prof. E. Forbes and Lonsdale as a coral near Orbitolites instead of a true Nummulites, cites a note from D'Orbigny, in which this author observes that it is near Orbitolina but pertains to his new genus Orbitoides, and should therefore be called *Orbitoides Mantelli.*

III. Zoology.

1. *Some Notes on Mexican Birds, heretofore not fully described;* by George A. McCall, U.S.A., (Proc. Acad. Nat. Sci., Philad., May, 1848, p. 63.)—*Orpheus curvirostris,*† Swainson.—Length 10 inches,

* See also this Journal, ii ser., vol. iv, p. 186.
† Called by Mexican peasants "Ouitacoche."

5 lines. The bill is curved and rounded on the ridge, the upper mandible slightly projecting; measured on the ridge it is 1 inch 2 l.; the commissure 1 inch 5 l.; its color dusky. Irides bright carmine, of conspicuous lustre; indeed, the eye is a striking feature of this bird. Tarsus rather robust, and 1 inch 5 l. in length; middle toe and nail 1 inch 3 l.

General color above, light hair-brown, fading to ash-color about the head, while towards the tail it deepens to chesnut. The feathers of the back are loose-webbed; and all the feathers at base are slate-color. Chin, throat, breast, belly and vent, whitish; the breast obscurely mottled with light brown. Primaries dusky, edged with white on the outer vanes; greater and lesser wing-coverts hair-brown, also slightly tipped with whitish. Lower tail-coverts hair-brown, broadly edged and tipped with whitish. Tail of twelve feathers, chesnut; the two middle ones loose-webbed, the three exterior tipped with white.

There is little difference between the sexes; the female is perhaps a trifle less in size, and its general markings are more obscure.

O. curvirostris is rather common about Matamoras, (Mexico.) The song of the male is a clear warble, not unlike the native notes of the mocking bird, but he has neither the imitative powers nor the volume of voice of the latter. On the Rio Grande, this bird nested in the hedge rows near the farm houses, and was constantly seen perched upon their roofs, singing with much volubility and all the familiarity of the house-wren.

Columba leucoptera, Linn.; *C. Trudeauii, or Texan Turtle Dove*, Audubon.—This very graceful bird—only one specimen of which Audubon mentions as having been received or seen by him—was exceedingly abundant at Matamoras in May and June, (1846,) large flocks daily feeding in our camp, and with remarkable confidence approaching quite near the tents. But although common in Mexico, I have some doubts as to the propriety of its being denominated a *Texan Dove*, for I never saw it in Eastern Texas, neither did I while on an extensive hunting excursion, which embraced the country along the Nueces river for seventy miles above Corpus Christi, see a single individual of this species, although game of every description was most abundant. Nor did I see one on the whole route from the Nueces to the Rio Grande, until we crossed the latter river *into* Mexico. Mr. Audubon's specimen was, therefore, possibly but a straggler from the neighboring republic.

About the last of June they disappeared from the vicinity of Matamoras, and passed probably into the interior. In January following, I shot a few stragglers, on small streams, near the *Sierra Madre*.

For the table, this bird is far superior to *C. carolinensis*, the breast being larger and fuller, and the meat of quite a delicate flavor. And in its style of flight it resembles *C. anas* more than *C. carolinensis*.

The female differs but little from the male, except that the metallic reflections on the neck, &c. &c. are less vivid.

2. *Description of new species of Birds of the genera* Vidua, Briss.; *Euplectus*, Sw.; *Pyrenestes*, Sw.; *and Pitylus*, Cuv.; *specimens of which are in the collection of the Academy of Natural Sciences of Philadelphia*; by John Cassin, (Proc. Acad. Nat. Sci. Philad., June, 1848, p. 65.)—*Vidua albonotata*, nobis.—Shoulders yellow.

Primaries white at their bases, and for about one-third of their length. Greater wing coverts also tipped with white, which, with that portion of the primaries of the same color, forms a conspicuous white spot on the wing. Lesser wing-coverts tipped with brown. All other parts of the plumage glossy black. Bill light blue, at the edges of the mandibles pearly white. Total length (of skin) from tip of bill to end of tail about $6\frac{1}{2}$ inches, wing 3, tail $3\frac{3}{10}$th inches.

Hab. Port Natal, Eastern Africa.

This bird belongs to that group of species which appears to form the genus *Coliuspasser*, Rüppel. From either of these species (*V. flavoptera*, Viell.; *V. macrocerca*, Licht.; *V. axillaris*, A. Smith and others) it may readily be distinguished by the white spot on the wing, and the pearly character of the bill.

Three specimens of this interesting species are included in the many valuable acquisitions of the Academy made through the judicious exertions of Mr. Edward Wilson, who secured them in Paris.

Vidua concolor, nobis.—Plumage entirely black. Bill strong, conical. General form and appearance of *Vidua payanensis*, Gm., (*V. rubritorques*, Swainson,) but the bill is larger, and the tail and wing feathers are broader, with no vestige whatever of the red collar which characterizes that species. Total length (of skin) from tip of bill to end of tail about 12 inches, wing $2\frac{8}{10}$; tail $8\frac{1}{2}$ inches.

Hab. Africa.

Of this species, one specimen only is in the Rivoli collection, without label. It is closely allied to the *Vidua rubritorques*, Swainson, but has the bill larger than either of ten specimens of the latter which I have examined. The entire absence of the red collar is, however, the most striking comparative character.

Euplectes nigroventris, *nobis*.—Entire upper parts of the plumage bright scarlet, except the wings and tail, which are hair-brown, with paler margins. Checks and entire under parts (from the base of the bill) deep black, except the thighs and under tail coverts, which are pale reddish-white.

Hab. Zanzibar.

Total length from tip of bill to end of tail, about $4\frac{1}{4}$ inches, wing $2\frac{3}{10}$ths, tail $1\frac{1}{2}$ inches.

This species, one specimen of which from the Rivoli collection is here described, is more nearly related to *Euplectes flammiceps*, Swainson, than to any other species known to me. From that species, as well as from all others of this genus, in which the bright scarlet plumage predominates, it may easily be distinguished by the uniform deep black of the entire under surface of the body. The inferior tail-coverts and thighs are pale reddish-white in the specimen now described, but I suspect that in the more adult bird, they become scarlet, and also that the wings and tail become darker.

Pyrenestes coccincus, nobis.—Head, neck, rump, upper tail-coverts and flanks, glossy crimson. Upper surface of the tail of the same color, but not so glossy. All other parts of the plumage, brown, some feathers of the back and a few of the wing-coverts margined with red.

Hab. Western Africa.

Total length from tip of bill to end of tail about $4\frac{4}{10}$ths inches, wing $2\frac{3}{10}$ths, tail $1\frac{3}{10}$ths inches.

Very similar in color to *Pyrenestes ostrinus*, (Viell.) but is much smaller and less robustly organized. The bill especially is comparatively weak. In the species now described the crimson does not extend to the breast as in *P. ostrinus*. The measurements of the two species are as follows:

	P. ostrinus, (Viell.)	*P. coccineus*, Cassin.
Total length (of skin) from tip of bill to end of tail about	$5\frac{6}{10}$ths inches.	$4\frac{4}{10}$ths inches.
Length of wing from flexure to tip of longest primary -	$2\frac{8}{10}$ths "	$2\frac{3}{10}$ths "
Length of tail - - -	$2\frac{4}{10}$ths "	$1\frac{9}{10}$ths "
Length of bill from gape -	$\frac{7}{10}$ths "	$\frac{5}{10}$ths "
Breadth of under mandible -	$\frac{7}{10}$ths "	$\frac{5}{10}$ths "

The dimensions of the specimen of *P. ostrinus* here given, agree almost exactly with those given by Mr. Swainson in Birds of Western Africa, (vol. i, p. 158,) and also with Viellot's plate *Ois. Chant.* pl. 48.

For a fine specimen of the rare *Pyrenestes ostrinus*, (Viell.) the only specimen in the collection of the Academy, we are again indebted to Mr. Edw. Wilson, who obtained it in Paris. The Academy possesses three specimens of the smaller species now described, two of which were presented by Robt. McDowell, M.D., Surgeon at Sierra Leone, and the other was presented, with other interesting birds, by Rev. Wesley Johnson, a pious and learned gentleman attached to an American Mission at Monrovia, Western Africa.

Pitylus flavo-cinereus, nobis. *Loxia canadensis*, Linn. variety A. Lath. Gen. Hist. V. p. 282.—Space about the base of the bill extending to the eyes, and including the chin, black. Front and top of the head, sides of the neck, breast, and under surface of the wings at the shoulders, bright yellow, running into green on the neck and back. Upper part of the back, wings and tail yellowish green. Scapular region, lower part of the back, rump, upper tail-coverts, abdomen and under tail-coverts light cinereous gray. Middle of the belly and under tail-coverts nearly white.

Hab. South America.

Total length, of skin, from tip of bill to end of tail about 7 inches, wing 4, tail 3 inches.

I have seen only one specimen of this species, which belonged to the Rivoli collection. It is nearly related to *Loxia canadensis*, Linn., which it strongly resembles in general appearance, but may at once be distinguished by the cinereous lower portion of the whole body above and below, which color is separated from the yellow of the breast by a well defined line, while in *L. canadensis* the entire inferior surface is bright yellow. The bill of the species now described is larger than that of either of eight specimens of *L. canadensis* which I have examined.

3. *Otters in Hadley, Mass.*, (Hampshire and Franklin Express, Nov., 1848.)—A few weeks since, (Sept. last) a pair of young otters were killed in Hadley by Mr. Elijah Cowles. They were in company with two other young and two old ones. The latter had been seen, during the summer, about Smith and Granger's pond in North Hadley;

and on one occasion, being annoyed by the barking of a dog, one of them suddenly leaped from the water, seized the dog, and drew him to the bottom, from whence in a depth of four feet, the dog was rescued by his master. Mr. Cowles met with this interesting family, when they were taking a walk in a grove near Adams' pond. Immediately they arranged themselves in an order favorable both for defense and retreat, one full grown animal being in front and the other in the rear. The latter bravely made fight, and seemed quite insensible to the blows of Mr. C.'s whip-handle. Having no other weapon, Mr. C. was able to kill only two of the young otters, which he has generously presented to the Zoological Museum of Amherst College. It is said to be thirty-five years since any otters have been seen in this immediate vicinity.

IV. Astronomy.

1. *Le Verrier's Remarks on the Planet Neptune.*—At a sitting of the French Academy held Sept. 11, 1848, M. LeVerrier communicated a paper respecting the identity of the planet Neptune with the theoretical planet of his computations. The following translation we take from the *London Athenæum* of Sept. 30.

"It is two years since I discovered the planet Neptune by means of the perturbations produced by it in the motions of Uranus. My earnest solicitations that my labors should be verified by means of a telescope were listened to at Berlin; and on the 23d of September, 1846, was begun, in the Prussian Observatory, the regular series of observations of Neptune.

"I had only arrived at the position of this planet by indirect means, and without having seen it. It was, therefore, impossible that I should have attained as much precision as the direct observations of the star itself would afterwards insure. Since it was necessary that I should make use of irregularities, on which I could only depend to within *a tenth* of their value (as I will hereafter explain, if desired), it would have been natural that this inaccuracy should influence the positions thence deduced for Neptune, and that these positions should be liable to an error of one-tenth. But I shall make it appear that the deviation from my theory is far inferior to this tenth. Hence it will naturally result that all assertions to the contrary are false. Without troubling myself more than necessary with the clamor attempted to be raised on this subject, I think it nevertheless my duty to take due notice of it; for if such an error should *for a time* take the place of truth, it would not fail to discourage deeply all those devoted to the progress of science.

"'The identity of the planet Neptune with the theoretic planet,' says M. Babinet, in his notice of the 21st of August last, 'is no longer admitted by any one, after the enormous differences discovered between them as to mass, period of revolution, distance from the sun, eccentricity, and even as to longitude (except at the epoch of the discovery of M. Galle, or for a very few years before and after).' If I quote this observation by the learned physicist, it is only because it sums up with infinite care all the pretended difficulties. I will go over each in particular, and reduce them successively to their real value. But I shall be permitted not to find a difficulty in the gratuitous assertion that

'the identity is no longer admitted by any one.' I say that after this discussion, no one will hesitate respecting the assertion of M. Babinet (*Personne* ne s'arrêtera au dire de M. Babinet).

"Let us first fix precisely the state of the question. I have determined the position of Neptune by means of the perturbations which it produces on Uranus. Accordingly, when such perturbations take place, I can find directly where Neptune is. But when there are no perturbations, this is impossible. Let this not be forgotten. Again, the action of one planet on another depends, at a given moment, only on its relative situation in the heavens and on its mass. The only facts, therefore, which I could conclude from the perturbations of Uranus, while they existed, were the direction in which Neptune was to be found, its distance from the sun, and its mass. Let us see how I have arrived at the determination of these three quantities.

"First.—*Is it true that the direction in which I have placed Neptune contains an enormous error, except for the epoch of M. Galle's discovery, or for very few years before and after? NO; this is false.* I place before the Academy of Sciences a chart of the respective situations of Neptune, in the orbit I have theoretically assigned to it and in the orbit resulting from direct observation. The latter positions have been taken from Mr. Walker, so as to avoid all suspicion of my having attempted to obtain a smaller deviation. According to this figure, the following are the minimum deviations from my theory:—

In 1857	+	4°·0
1847	+	1 ·0
1837	—	0 ·7
1827	—	2 ·0
1817	—	3 ·1
1807	—	4 ·5
1797	—	6 ·6

It follows that *during sixty-five years*, my theory, deduced from indirect considerations, assigns to Neptune a series of positions never differing from those obtained by the direct orbit by more than *one fifty-fifth*, at the most, of the circumference of a circle. And this is called a small number of years, when it is known that Neptune has had a sensible effect on Uranus for only twenty-five or thirty years at the utmost! The *fifty-fifth part* of the circle! This is what is called an enormous error, when it is known that the data which served as basis to my theory are only known to *a tenth*. But I do not insist on this subject, as I hear M. Babinet declare, that when he spoke of *enormous errors*, he had not calculated them, and imagined them much more considerable than they are in reality. But, it will be said, if we go beyond these sixty-five years, we should find more considerable deviations. Yes, without doubt. That results from the nature of the question; it cannot be avoided. I have said that I determine the position of Neptune by means of the perturbations it produces on Uranus. When there are perturbations, I can say where Neptune shall be found; but to ask of me to do so, long after the perturbing action has disappeared, is simply to ask an impossibility—a sort of miracle. Now, in examining my plate—which in a few days I shall place before the public, and in which I have traced the course of Uranus—it appears clearly that this planet

has been influenced by the action of Neptune only from 1812 to 1842, —that is, during only thirty years.

"It is then during these 30 years only that I have been able to determine directly the position of Neptune: and yet the deviation from my theory is only 3°·7 in 1812, at the time when the action of Neptune, which then only commences, was not yet clearly determined. Then, in proportion as this action develops itself, the precision of my indications increases; and in 1842, at length, when I have at my disposal all the action of the planet, I am mistaken by no more than a fifth of a degree only—that is, by an 1,800th part of the circumference—in predicting the direction in which Neptune should be seen.

"Thus, far from reproaching my theory with having made the trifling error of 4°·0 in 1807 and of 6°·6 in 1797, it should rather be asked, how it could give with such precision the position of Neptune at an epoch when it did not act upon Uranus? In fact, this is only obtained by prolonging arbitrarily the curve which I had obtained from 1812 to 1842; a prolongation with which my object had nothing to do (*qui n'est pas de mon fait*) and which is not legitimate when pushed too far. During these thirty years Neptune has performed only a sixth part of its orbit; an ellipse is very ill determined by an arc including only a sixth part of its extent.

"During the whole of the last century, from 1700 to 1812, Neptune has in nowise acted upon Uranus. It has had less influence on it than on Saturn,—which it does not sensibly disturb. When I am required to say, by my theory, where Neptune was in the middle or at the commencement of the last century, I repeat it, a miracle is demanded of me.

"I have then the right to say—It is false that I have committed an enormous error in the longitude at every other epoch but that of Galle's discovery or of a few years before and after. During the whole period that Neptune has acted upon Uranus my theory has not deviated from that deduced from direct observations by more than $\frac{1}{9}^{\frac{1}{1}}$ of the circumference. And now it is said that the discovery made by Galle is a fortuitous accident! Really, then, planets of twice the size of Uranus and yet unknown, although shining like stars of the seventh magnitude, are scattered in such numbers over the heavens that there is nothing surprising if, on pointing by chance to any spot in the firmament there should be great probability of finding one! And it is, no doubt, on account of their numbers, and because there would be no merit in discovering them, that our observers disdain to do so.

"Secondly.—*Is it true that there are enormous errors respecting the distance from the Sun? NO; this is false.* Figures have their eloquence. Here are, according to my plate, the distances from the Sun in the two orbits for the thirty years during which Neptune has acted upon Uranus.—

	Distances in the predicted orbit.	In Walker's orbit after the discovery.
In 1812	32·7	30·4
1822	33·3	30·3
1832	32·6	30·2
1842	32·8	30·1

How is the difference of the two theories to be estimated? In refer-

ence to the distance itself which is to be valued? Whoever, in order to strike the imagination of the public, should express this difference in post-leagues, that is, referring it to the slowness with which we crawl upon the surface of our globe, would be following a proceeding unworthy of an astronomer. Now, in 1812 I have made an error of $\frac{1}{14}$th of the distance, in 1822 and 1832 $\frac{1}{16}$th, and in 1842 $\frac{1}{13}$th; never the *tenth* which I might have reached without being liable to any reproaches.

"The direction was more precise than the distance. This might be,—for if the direction had been false, nothing could have compensated for the error which would have resulted in the attraction of Neptune upon Uranus. Whilst, if the planet be placed a little too far in a given direction, the error, which would result in the quantity of attraction, may be immediately destroyed by making the planet a little larger. This is precisely what has taken place. I placed Neptune rather too far; but I made it rather too large. I might have placed it in any intermediate place, even a little too near, provided I had made it a little too small. But what am I saying? I have made Neptune too large! I forgot that this is a third objection. Let us examine it however.

"Thirdly.—*Is it true that the theoretic mass of Neptune differs from the mass deduced from observations of the satellite, to such a degree as to be an irresistible argument against the identity of the theoretic Neptune with the observed Neptune? NO; this is false.* Let us again have recourse to figures. According to M. Struve the mass deduced from the satellite is $\frac{65}{100}$ of the mass I had predicted. But I will grant, if it is insisted on, that $\frac{52}{100}$ must be taken; which, however, is only arrived at by choosing from among the different results obtained that which leads to the greatest deviation. I declare that if any one should be misled by this deduction, which corresponds only to a variation of a fifth in the diameter of Neptune, it would only be by keeping out of sight the difficulties of the same kind presented by the masses of the other planets. The mass of Uranus has been also determined by two different methods—by the action of this planet upon Saturn, and by the consideration of its satellites. Well, the second of the values thus determined is only $\frac{7}{10}$ of the first. And yet there were forty years of direct observation of Uranus at disposal whilst I had not a single observation of Neptune. And yet the mass only of Uranus was required to be deduced from its perturbations on Saturn, whilst I sought, from those of Neptune on Uranus, the direction, the distance, and the mass of the planet. Will it be said then that there are two planets Uranus? It should, to be consistent. Thus, then, the direction, the distance from the Sun, the mass of Neptune—that is to say, the only three things which might justly be required—are exact in my theory beyond all hope. The Neptune which has been found, like that which I sought, satisfies perfectly the perturbations of Uranus. This great accusation, which has made so much noise, falls back into that nothingness from which it ought never to have emerged. I might stop here. A few more words, however, to show how the public is abused by pretended enormous unheard-of errors held up to it. Around the principal star γ Virginis, and under the influence of its action, revolves another star to which observations, made from 1718 till 1835, an interval of 117 years, had assigned a certain elliptical orbit. Ten years of new observations

had sufficed to make this ellipse be abandoned and replaced by another whose surface is nearly five times smaller than that of the former! Will it be said that the star observed before 1835, is not that observed since that time? Moreover, the two ellipses are by the same illustrious astronomer, Sir John Herschel. I do not know that he has been reproached in his own country for not having drawn from observations more than they contained. And comets! There is a comet whose motions during one part of its path may be represented indifferently by a parabola or an ellipse, whose planes would be inclined at more than 60°. Every one is acquainted with the magnificent labors by which Bessel has determined the distance of a star in Cygnus from the earth. Bessel also determined the error which might be feared in the result he obtained. Now translate this inaccuracy into post-leagues, and you will throw ridicule *(in your way of viewing it)* on a work which is the admiration of the world. The error is 1,000,000,000,000—that is, one billion of post-leagues. I shall conclude by considering the distance of the Sun from the Earth,—which has cost astronomers so much labor, so many journeys, dangers, and almost martyrdom. The measurement of this fundamental element of our system has presented, in the hands of the greatest astronomers, discordances greater than those objected to me. It may be obtained in two ways—by means of Mars, or of the transits of Venus across the Sun. The first method is less precise than the second; but in return it may be repeated as often as desired, while the second can be employed only twice in about 120 years. Mars was the first employed in 1750 by Lacaille and by other astronomers of vast merit. They never found by this means more than 32,271,000 post-leagues for the distance of the Earth from the Sun. And the agreement of the results obtained by repeated measurements gave perfect confidence in this number. Now when the transit of Venus across the sun occurred in 1769, a distance of 38,416,000 post-leagues was obtained by means of this transit. The difference of the two results, 6,145,000 leagues, is simply the fifth part of the former. I will add that the difficulty is not completely resolved at present. I have never had such a difference. Should it not be admitted then, for the sake of consistency, that there are two Suns, as there are two Neptunes,—the Sun of Mars, and the Sun of Venus." * * *

2. *Eighth Satellite of Saturn.*—The eighth satellite of Saturn, which was first noticed by Mr. Bond, of the Observatory at Cambridge, Massachusetts, Sept. 16, 1848, was detected two days later by Mr. Lassell, of Liverpool, with the aid of his large reflector. Both discoverers have agreed to call it *Hyperion.* A full account of the circumstances of each discovery, is given in the Appendix of vol. iii, of the new series of the *Memoirs of the American Academy.*

3. *Elements of Petersen's Comet of Aug.*, 1848, (Institut, No. 770.)—Prof. Schumacher has furnished the following elements of the comet discovered August 7, 1848, by Dr. Petersen, of Altona.

Perihelion passage, 1848, Sept. 8·0560 m. t. Gr.

Longitude of perihelion,	310° 34′ 36″	App. Eqx.
" " ascending node,	211 34 36	Aug. 19.
Inclination,	84 28 22	
Log. of perihelion distance,	9·504875.	
Motion,	Retrograde.	

4. *New Comet.*—On Saturday, Nov. 25, 1848, at 6½ P. M., Mr. Geo. P. Bond, Assistant at the Cambridge Observatory, discovered a telescopic comet in the constellation Cygnus. Its place Nov. 25, 6^h 57^m, was A. R. 20^h 35^m 11^s and N. decl. 37° 21′ 50″.

The following elements are derived from the earlier observations.

	Prof. Peirce.	Mr. G. P. Bond.
Perihelion pass. Gr. m. t. 1849,	Jan. 19·238	Jan. 19·432.
" distance,	0·9526	0·9601
Long. of perihelion,	70° 16′	6° 30′
" " asc. node,	215 46	215 02
Inclination,	84 29	85 13

Motion direct.

At its descending node, the comet passes very near the orbit of the earth.

5. *Comet Medal.*—The king of Denmark has directed the comet medal founded by his predecessor, to be awarded to Miss Maria Mitchell, of Nantucket, for her discovery of the telescopic comet, discovered Oct. 1, 1847. This is the first instance in which the comet medal of the king of Denmark has been awarded to a lady.

6. *Some Remarks upon an American Nautical Almanac*, (communicated for this Journal.)—Encouraged by the recent rapid progress of their science in this country, our astronomers are beginning to aspire to the possession of an ephemeris of their own. This important work will not be undertaken, however, merely as an object of national pride, nor for the sake of being independent of the labors of other countries. As Americans, we naturally wish to see our country among the foremost in the pursuit of science, but her title to distinction will be judged by the intrinsic value and importance of her contributions to science itself, which is "of no country and of no nation." The question, then, which presents itself for consideration, is not simply "shall the United States have an astronomical ephemeris of their own?"—but "does *astronomy* need a new one and a better one than it already possesses?" If the latter question is answered in the affirmative, it will not be doubted that the United States should not fail to improve so good an opportunity of rendering a valuable service to science.

The ephemeris may be regarded as the exponent of the actual state of astronomical science, at least so far as relates to the objects contained in it. It professes to predict for certain given times, the exact places of the principal heavenly bodies, and to furnish for the convenience of both the observer and the computer all the astronomical quantities that are simply functions of the time. To be of any use in enlarging the boundaries of the science, it is plain that every one of these quantities should be given with the greatest possible degree of accuracy; and when a correction has been obtained for any one of them, it should be immediately incorporated into the ephemeris.

Now, that the present ephemerides of Greenwich, Berlin and Paris, do not entirely fulfill these conditions, will appear upon a reference merely to the dates of the astronomical tables upon which they are based. Thus the ephemeris of the sun is prepared from Carlini's Tables appended to the "Effemeridi Astronomiche di Milano per l'anno 1833;" that of the moon from Burckhardt's "Tables de la Lune, Paris,

1834;" Mercury, Venus, Mars, from Lindenau's Tables, 1810–13; Jupiter, Saturn, Herschel, from Bouvard's Tables, 1821. Since these dates, an immense mass of observations has accumulated, from which doubtless important corrections may be deduced for almost every element involved in the construction of the tables. The great work, therefore, which invites the labors of American astronomers is a full revision of these tables, or rather of the theories of the sun, moon and planets, indeed of the whole solar and stellar systems, and the construction thereon of *new* tables which shall bring in all modern observations at Greenwich, Cambridge, Oxford, Edinburgh, etc., in Great Britain; at Paris, Berlin, Pulkova, Königsberg, Munich, Vienna, and many other places on the continent; at Washington and other places in our own country. This would be a work worthy of the nation, and might engage our ablest astronomers and computers.

It will be observed that we do not propose to make an American Nautical Almanac by interpolating the European books to the meridian of Washington, nor by making separate computations from the same tables. Such works would add nothing to the stock of astronomical knowledge and little or nothing to the scientific reputation of the country. Nor do we propose an exclusively nautical work. A complete astronomical ephemeris will of course include what is requisite for the purposes of navigation; but if it were confined to this object it would be of little use to the astronomer engaged in improving the science itself. He requires the extreme of accuracy; the navigator only such a degree of precision as will enable him to determine his position within certain practical limits.

Since such a work as has been described requires the coöperation of the ablest astronomers of the country, some organization is necessary under a superintendent whose scientific character shall command the confidence of mathematicians. For this we look only to the general government. Let Congress authorize the President to appoint such a superintendent, with a certain number of assistants, and let all the salaries attached to these offices be sufficient to command the services of the most competent persons. The national character of the work precludes the idea of confining it to officers already in the service of the government. At the last session of Congress a proposition was made to commence an American Nautical Almanac, under the superintendence of a captain, commander or lieutenant of the navy. Now we do not question the possibility or probability of finding a suitable officer among those grades; indeed, we hail with delight every thing that tends to promote or encourage scientific attainments among them; but we must deprecate the passage of *a law* which would pronounce our professed astronomers, who devote their lives to the science, to be less competent to take charge of important astronomical works than those who by profession are devoted chiefly to other pursuits. It is not to be supposed, indeed, that it was the intention of the originator of this proposition so to pronounce. It was doubtless supposed that a nautical almanac was simply designed for practical use at sea, and that a nautical work could be best prepared only by nautical men; to which it is sufficient to reply, that the ability to use an instrument does not necessarily imply ability to construct it. There might also have been some idea of

economy in employing only those who are already in the pay of the government.

Let us hope that when this subject is again brought before Congress, the proper character of the undertaking will be duly considered, and such a system matured as will unite the labors of *all* our best astronomers, in the navy and out of it, in producing a truly national work, and a worthy contribution to the science of the world.*

V. Miscellaneous Intelligence.

1. *Gold in California.*—It is now several months since the discovery of gold in California, (see vi, 271.) Mines are said to have been known to exist there by the Jesuits; but if so, they had been long forgotten. The first gold was found on a tributary of the Sacramento, called the American Fork, at a point fifty miles northeast of Capt. Sutter's settlement. Capt. Sutter contracted in September, (1847,) for lumber with a Mr. Marshall, and as this place abounded in pine, a sawmill was here built for the purpose. In the course of operations the following spring, the water carried away a large bed of mud and gravel. Mr. Marshall's attention was attracted by some glittering particles at the edge of the mud, and soon satisfied himself of their value. This stream, and others flowing into it, have since afforded large quantities of the precious metal. Weber's creek is the name of one of the streams, and all the ravines emptying into it, as well as its own course, have proved productive as far as examined. Feather river, with its branches Yubah and Bear river, and other eastern affluents of the Sacramento to the North, flowing from the Sierra Nevada, yield gold abundantly; and also, as stated, in the valley of the San Joaquim.

The gold occurs in grains, but occasionally in pieces weighing several ounces. It is found in the sand or gravel of the streams and ravines, and is obtained by washing in the rudest manner. Fifty dollars a day for an individual appear to be a moderate yield, with only a shovel, and a tin pan or wooden bowl for washing; and 250 to 500 dollars a day is not an unusual amount. The sands, after such a coarse operation, must still be of great value for the process of amalgamation. Fortunately the same district, nearer the coast, has just disclosed vast mines of quicksilver, (see vol. vi, 270.) Gold is also stated to be found in the rocks of the mountains.

Governor Mason states in his Report, dated Aug. 17, that about 4,000 men were working in the gold districts, and that from $30,000 to $50,000 worth of gold were daily obtained. The increase since has been great. Assays recently made at the U. S. Mint, at Philadelphia, show a variation in fineness from 892 to 897 thousandths. This is slightly below the standard fineness, which is 906. The value before melting is $18.05½ per ounce, and after melting $18.50.

Platinum is also mentioned among the products of this region.

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* It has been suggested that a Nautical Almanac, strictly so called, might be prepared in addition to the general astronomical ephemeris. This may be worth considering in connection with the plan suggested. The larger work might easily be so arranged as to admit of the separate publication of the nautical portions, and in these portions some improvements might be made with especial reference to the convenience of navigators.

Gold is also stated to occur on the eastern side of the Sierra Nevada; and it is reported that the Mormons have found other mines near the Great Salt Lake.

[The writer, when in the region of the Sacramento, in the fall of 1841, (having then journeyed on horseback with a party from Fort Vancouver to San Francisco, and followed down the Sacramento from its source,) remarked the fact that the region resembled other gold districts in its rocks, and has a sentence to this effect in his Geological Report of the country, written out at the time, though but just now being published. The character of the country may occupy some pages in a future number of this Journal.—J. D. DANA.]

2. *Auroral Bow of April* 7, 1847.—About 10 P.M., April 7, 1847, a well defined and bright Auroral bow, spanning the heavens from East to West, and passing the zenith, was seen throughout the Northern, Middle, and Western States. Some account of the phenomenon was given in this Journal, vol. iii, ii ser., p. 440, and vol. iv, p. 145. A description of the same is also furnished by Mr. Daniel Kirkwood, in the *Literary Record of Linn. Assoc. of Penn. College, Gettysburg*, vol. iii, p. 188, June, 1847. The object being isolated, distinct, and regular in its motion, the opportunity for determining its elevation was a most favorable one. Observations were secured by Dr. P. W. Ellsworth, at Hartford, and by myself at New Haven, from which it results that the bow was elevated *one hundred and ten miles* above the earth. The original observations which were for a long time mislaid, are now published in order that all who are interested may be able to determine the value of this conclusion.

(1.) *Observations at Hartford.* N. lat. 41° 45′ 53″; W. long. 72° 40′ 45″

9h	59m	0s	H. m. t. Southern edge of bow is half way between *Regulus* and *eta Leonis.*
10	0	30	" " at *Regulus.*
"	2	30	" " at *pi Leonis.*

The times above given were taken by a lever watch of regular movement. This was compared early next morning with a clock which was kept correct by transit observations. The watch was then found 2m. 20s. fast, and may safely be assumed to have varied but a few seconds during the night. The times are consequently to be diminished 2m. 20s.

(2.) *Observations at New Haven.* N. lat. 41° 18′ 33″; W. long. 72° 56′ 45″

9h 54m	N. H. m. t. Bow complete and brilliant: southern edge rather more definite than the northern; both well defined.
56	Southern edge touches *Pollux; Castor* is also within the bow, which is here a little wider than the distance between these stars.
56m 40s	Southern edge touches *mu Leonis.*
57	Northern edge touches *Castor.*
58	Southern edge touches both *epsilon* and *zeta Leonis.*
59	The bow for 10° or 15° each side of the meridian is bent convex towards the North.
10 0 10	Northern limb touches Arcturus; a waving motion is visible within the bow about the meridian; the movement being from E. to W.

10h	2m	0s	Bow distinct and brilliant; narrower than before.
	2	30	Eastern end begins to disappear.
	4	0	Bow irregular in its curvature; serpentine.
	5	0	*Gamma Geminorum* in the middle of the bow.
	6	0	Bow breaking up into oblique beams. Tall streamers in the North.
	8	0	Bow nearly extinct. Northern sky very light.

The observations were taken with a lever watch, which, at 10h. 25m. was compared with a chronometer whose error was known by recent transit observations. The error of the watch thus ascertained, has been applied to the observations, so that they are given above in New Haven mean solar time.

The base line is not so long as could be wished, yet most of the circumstances were uncommonly favorable, and on looking at numerous similar cases I find none which seems to furnish more reliable ground for computation. Making liberal allowances for uncertainties of all sorts, we may be quite sure of the result stated at p. 145 of vol. iv, viz. that this arch or bow "*was elevated not less than* 100 *miles nor more than* 120 *above the earth's surface.*"

This result confirms the general conclusion obtained by Dalton (Philos. Trans. Roy. Soc., 1828, p. 302,) that rainbow-like auroral arches have an elevation of about *one hundred miles* above the earth's surface. It is however quite probable that they differ in height, and that more are above than below the altitude assigned by Dalton. It is not unlikely that they rise as they travel South, but this has never been proved.

Not being able from my position to see the extremities of the bow of April 7, I have no satisfactory means of determining its extent. It was certainly not less than a thousand miles in length, and from ten to fifteen miles in width. Its motion Southward was probably about three miles a minute.

E. C. Herrick.

3. *Aurora Borealis*, Nov. 17, 1848.—On Friday night, Nov. 17, 1848, an auroral display of extraordinary magnificence was witnessed wherever the sky was clear throughout the northern portion of our country. At New Haven, where the sky was overcast, the red light was seen through the clouds, and the snow on the earth faintly reflected a rosy hue. The accounts received from various quarters lead us to infer that this exhibition was fully equal to any which is ever seen in this region.

Subsequent to the 17th, the Aurora was visible here every night to the 28th inclusive, except the 20th and 24th, (and the latter night was cloudy;) being sometimes conspicuous, and at other times very faint.

It is reported in the newspapers that the Aurora Borealis of the 17th inst., was seen at Principe, in Cuba, lat. 21° N., and on the 26th at Neuvitas, lat. 21½° N. It is said to have been remarkably brilliant in the N.E. for several hours;—whether on both occasions, or only on the former, is not stated. This is a rare phenomenon in that latitude.

By Scotch and English papers, we learn that an Aurora of unusual splendor was also seen in Britain on the evening of the 17th.

E. C. H.

4. *Relation between the Coëfficient of Elasticity of Metals, and their latent heat of fusion;* by C. C. PERSON, (Comptes Rendus, Sept. 4, 1848, p. 258.—The expenditure of heat by which molecules are separated in fusion, equals the latent heat of the substance. The author conceived that the work accomplished in this separation should have a simple relation to the work necessary for separating to a less amount. It is already obvious that there is a remarkable relation between the coëfficients of elasticity of metals and their latent heat. It requires double the force to elongate zinc as tin; and it takes an expenditure of twice the heat to melt it. Lead requires five times less force for the same elongation than zinc; and its fusion requires five times less of heat. A similar relation exists between zinc and bismuth, if the zinc be well crystallized.

Designating by q, q', the coëfficients of elasticity of two metals, by l, l', their latent heats of fusion, we have approximately $q : q' :: l : l'$. It is natural that the proportion should not be exact:—$l : l'$ is the relation between the quantities of heat expended in melting the same quantity of two metals; $q : q'$ is the relation between the forces necessary to produce the same elongation in two pieces of metal of the same size and consequently of unequal weights. It is obvious that the latent heat of fusion should be proportioned not to the coëfficient of elasticity, but to a function of this coëfficient representing the work required to destroy the cohesion of molecules comprised in a unity of weights, or at least to reduce this cohesion to what it is in the liquid state. The formula thence becomes

$$\frac{q}{q'}\left\{\frac{1+\frac{2}{\sqrt{p}}}{1+\frac{2}{\sqrt{p'}}}\right\}=\frac{l}{l'}$$

The formula is verified by experiment. For zinc and lead, $\frac{q}{q'}=1{\cdot}80$; the correction, dependent on their densities $(p, p',)$ being made, we have $5{\cdot}28$; but $\frac{l}{l'}=5{\cdot}23$, which is a close approximation. For tin and lead $\frac{l}{l'}=2{\cdot}65$; $\frac{q}{q'}=2{\cdot}20$, and the correction applied gives $2{\cdot}42$. For zinc and tin, the densities being the same, the correction becomes nothing; the relations $\frac{q}{q'}$ and $\frac{l}{l'}$ are equal or nearly so; for $\frac{l}{l'}=1{\cdot}97$; and then, according to the specimens of metals and different modes of vibration, we have for $\frac{q}{q'}$ the values $2{\cdot}00, 2{\cdot}09, 2{\cdot}11$, which differ little from $1{\cdot}97$.

If we apply it to platinum and iron, taking zinc for a term of comparison, we find $l=38$ for platinum, and $l=60$ for iron; iron being the most resistant and demanding not the highest temperature, but the greatest amount of latent heat for fusion. Reciprocally, mercury whose latent heat of fusion is so small, offers still less tenacity than lead.

By experiments on cadmium and silver, the author finds the latent heat of the two $13{\cdot}66$ and $21{\cdot}7$; and by the formula $13{\cdot}52$ and $20{\cdot}38$.

5. *On the Existence of the Color Brown;* by ERNEST BRUCKE. (From Poggendorff's Annalen, No. 7, 1848, having been read before the Physical Society of Berlin on the 23d of June, 1848; Phil. Mag., xxxiii, 281.)—Brown is wanting in the prismatic spectrum, and its relation to the colors of the spectrum is as yet unknown. Any one may, however, easily convince himself that brown is nothing more than the complementary color to that of Herschel's lavender-gray rays, *i. e.* white light from which these rays have been removed.

For this purpose, separate plates should be split from crystallized gypsum in such a manner that on one side they are as thin as possible, and from it gradually increase in thickness in broad terraces. One of these plates is placed under the microscope, which must be furnished with two Nichol's prisms, one beneath the object-glass, and one in the eye-piece, and so arranged, the prisms being parallel, and the linear magnifying power being about twenty diameters (at a distance of eight French inches), that the above-mentioned thin side is in the field. If it is sufficiently thin, no color is perceived immediately at the side; but as we proceed towards the thicker part, at first a pale brown tint becomes visible, as if we were looking through a very thin plate of horn, and as the thickness of the plate gradually increases in broad and low terraces, the brown continues to become darker until it assumes a deep and pure nut-brown color, without the intervention of any of the prismatic colors which the thicker parts of the plate exhibit.

It is evident that the plate at the margin where it appears colorless is so thin, that the difference of the path of the ordinary and extraordinary ray on their exit does not amount to half the length of a wave for any color. Thus interference of the most refractive rays does not occur until the thickness is greater, and the brown color must therefore be produced by the disappearance of the lavender-gray rays from the compound light.

The correctness of this conclusion is readily tested. On crossing the prisms, it is seen that whilst in the case of all the other colors of the plate the well-known complementary colors appear, that portion which was previously brown becomes colored lavender-gray, and the intensity of this color is in proportion to the depth of the brown previously observed at the same spot.

6. *Inundation of the Indus.* Taken from the lips of an Eye-witness in A. D. 1812. Communicated by Captain J. ABBOTT, (Jameson's Jour., Oct., 1848, xlv, p. 393. Journal of the Asiatic Society of Bengal. New series, No. 188, p. 230.)—Ushruff Khan, Zemindar of Torbaila, states,—"In the month of Poos (December), the Indus was very low. In Maag and Phagoon (January and February), it was so low as to be fordable (an unprecedented phenomenon). In Chayt, it continued very low, but not fordable. In Bysakh (April) the same. About the middle of Jayt (May), the atmosphere was one day observed to be very thick, the air still. At about 2 P. M., a murmuring sound was heard from the northeast, amongst the mountains, which increased until it attracted universal attention, and we began to exclaim, 'What is this murmur? Is it the sound of cannon in the distance? Is Gundgurh bellowing? Is it thunder?' Suddenly some cried out, 'The rivers come!' and I looked and perceived that all the dry channels were already filled, and that

the river was racing down furiously in an absolute wall of mud, for it had not at all the color or appearance of water. They who saw it in time easily escaped. Those that did not were inevitably lost. It was a horrible mess of foul water—carcasses of soldiers, peasants, war-steeds, camels, prostitutes, tents, mules, asses, trees, and household-furniture—in short, every item of existence jumbled together in one flood of ruin; for Rajah Goolab Singh's army was encamped in the bed of the Indus at Koolaye, three koss above Torbaila, in check of Poynda Khan. Part of the force was at that moment in hot pursuit, or the ruin would have been wider. The rest ran, some to large trees, which were all soon uprooted and borne away; others to rocks, which were speedily buried beneath the waters. Only those escaped who took at once to the mountain side. About 500 of these troops were at once swept to destruction. The mischief was immense. Hundreds of acres of arable land were licked up and carried away by the waters. The whole of the Seesoo trees which adorned the river's banks; the famous Burgutt tree of many stems—time out of mind the chosen bivouac of travellers—were all lost in an instant. The men in the trees, the horses and mules tethered to the stems, all sunk alike into the gulf, and disappeared for ever. As a woman with a wet towel sweeps away a legion of ants, so the river blotted out the army of the Raja. There were two villages upon an island opposite Ghazi. One of the inhabitants was returning from Strikote and descending the mountain; when he came within sight of the spot where he had left all he held dear, he naturally looked with affection toward his home. Nothing was visible but a wide-rushing sea of mud. His house, his friends, his household, his village, the very island itself had disappeared. He rubbed his eyes in mortal terror, distrusting his sight, hoping it was a dream. But it was a too horrible reality. He alone, of all that busy hive of moving, struggling, hoping, fearing beings, was left upon the earth."

So far the Zemindar: and to this eloquent description of an eye-witness, I need only add, that it will take hundreds, if not thousands of years to enable time to repair with its healing hand the mischief of that terrible hour. The revenue of Torbaila has, in consequence, dwindled from 20,000 to 5000 rupees. Chuch has been sown with barren sand. The timber, for which the Indus had been celebrated from the days of Alexander until this disaster, is now so utterly gone, that I vainly strove throughout Huzara to procure a Seesoo tree for the repair of the field artillery carriages. To make some poor amends, the river sprinkled gold-dust over the barren soil, so that the washings for several successive years were farmed at four times their ordinary rent. It is generally believed that the accumulation of the waters of the Indus was occasioned by a landslip which blocked up the valley; but this and other interesting questions we must leave for solution to Mr. Vans Agnew, whose late mission to Gilet promises so much to the lovers of science.

7. *Flood in the Macquarie, in Australia;* (Jameson's Jour., Oct., 1848, xlv, p. 395. Lieutenant-Colonel Sir T. L. Mitchell, Kt., on Tropical Australia, p. 56.)—The talented and energetic Sir Thomas Mitchell, Surveyor-General of New South Wales, in his lately-publish-

ed Travels in Tropical Australia, gives the following graphic account of a flood in the Macquarie :—

"13th February.—I was again laid up with the *maladie du pays*—sore eyes. Mr. Stephenson took a ride for me to the summit of Mount Foster, and to various cattle-stations about its base, with some questions, to which I required answers, about the river and stations on it lower down. But no one could tell what the western side of the marshes was like, as no person had passed that way ; the country being more open on the eastern side, where only the stations were situated ; Mr. Kinghorne's, at Gràway, about five miles from our camp, being the lowest down on the west bank. Mr. Stephenson returned early, having met two of the mounted police. To my most important question—What water was to be found lower down in the river ? the reply was very satisfactory, namely, 'Plenty, and a *flood coming down* from the Turòn mountains.' The two policemen said they had travelled twenty miles with it on the day previous, and that it would still take some time to arrive near our camp. About noon the drays arrived in good order, having been encamped where there was no water, about six miles short of our camp ; the whole distance travelled, from Cannonbà to the Macquarie, having been about nineteen miles. In the afternoon two of the men, taking a walk up the river, reported, on their return, that the flood poured in upon them, when in the river-bed, so suddenly, that they narrowly escaped it. Still the bed of the Macquarie before our camp continued so dry and silent, that I could scarcely believe the flood coming to be real, and so near to us, who had been put to so many shifts for want of water. Towards evening, I stationed a man with a gun a little way up the river, with orders to fire on the flood's appearance, that I might have time to run to the part of the channel nearest to our camp, and witness what I had so much wished to see, as well from curiosity as urgent need. The shades of evening came, however, but no flood ; and the man on the look-out returned to the camp. Some hours later and after the moon had risen, a murmuring sound like that of a distant waterfall, mingled with occasional cracks as of breaking timber, drew our attention, and I hastened to the river-bank. By very slow degrees the sound grew louder, and at length so audible, as to draw various persons besides from the camp to the river-side. Still no flood appeared, although its approach was indicated by the occasional rending of trees with a loud noise. Such a phenomenon, in a most serene moonlight night, was quite new to us all. At length, the rushing sound of waters and loud cracking of timber, announced that the flood was in the next bend. It rushed into our sight, glittering in the moonbeams, a moving cataract, tossing before it ancient trees, and snapping them against its banks. It was preceded by a point of meandering water, picking its way, like a thing of life, through the deepest parts of the dark, dry, and shady bed, of what thus again became a flowing river. By my party, situated as we were at that time, beating about the country, and impeded in our journey, solely by the almost total absence of water, suffering excessively from thirst and extreme heat, I am convinced the scene never can be forgotten. Here came at once abundance, the product of storms in the far-off mountains that overlooked our homes. My first impulse was to have welcomed

this flood on our knees, for the scene was sublime in itself, while the subject—an abundance of water sent to us in the desert—greatly heightened the effect to our eyes. Suffice it to say, I had witnessed nothing of such interest in all my Australian travels. Even the heavens presented something new, at least uncommon, and therefore in harmony with this scene; the variable star η Argus had increased to the first magnitude, just above the beautiful constellation of the southern cross, which slightly inclined over the river, in the only portion of sky seen through the trees. That very red star, thus rapidly increasing in magnitude, might, as characteristic of her rivers, be recognized as the star of Australia, when Europeans cross the line. The river gradually filled up the channel nearly bank high, while the living cataract travelled onward, much slower than I had expected to see it; so slowly, indeed, that more than an hour after its first arrival the sweet music of the head of the flood was distinctly audible from my tent, as the murmur of waters and the diapason crash of logs travelled slowly through the tortuous windings of the river bed. I was finally lulled to sleep by that melody of living waters, so grateful to my ear, and evidently so unwonted in the dry bed of the thirsty Macquarie. Thermometer at sunrise, 47°; at noon, 79°; at 4 P. M., 88°; at 9, 63°—with wet bulb, 57°.

8. *On the Apparent Motion of the Figures in certain Patterns of Blue and Red Worsted;* by HENRY TAYLOR, Esq., (Phil. Mag., xxxiii, 345, Nov., 1848.)—The apparent motion of the figures in certain patterns of blue and red worsted is sufficiently well known to have excited some attention among the learned as well as the unlearned, but, so far as I know, without receiving any satisfactory explanation. After having examined the subject for some time, I believe I have succeeded in making out the cause of this singular phenomenon; and if the following observations are deemed of sufficient importance, I should be glad to have them inserted in the pages of your Journal.

If certain patterns of blue and red worsted-work are examined by candle-light, it is found that when they are moved about, the figures have a tremulous appearance as if they were moving faster than the ground of the pattern—and blue and red are the only colors exhibiting this remarkable property—although it must be observed that some persons are so constituted as not to perceive the illusion under any circumstances.

The usual patterns consist of blue and red figures on a ground of the opposite color, several of them being arranged together on the same piece; but for the purpose of experiment, it is better to have patterns of the simplest kind, and I shall suppose them now to consist of single spots, of red on a blue ground and blue on a red ground.

If the pattern is moved up and down before the eye, and attention is directed to the red spot, we may observe a change of color taking place at its edge, like a dark border or shadow flitting from one side to the other. On close examination, it will be found that as the pattern is moved upward, this dark border appears only at the upper edge of the spot, and but for an instant; as the pattern descends, it is seen again at the lower edge, vanishing as before. When the movement is made from side to side, instead of up and down, a similar appearance may be seen on the right and left of the spot.

If the blue spot is now examined in the same manner, it will present an appearance somewhat different, the borders that form on its edge being of a lighter color than the rest of the spot, and having the effects of lights instead of shadows, as in the former instance.

These changes of tint are so momentary, that they require very close attention in order to be seen at all; and the best way of discovering them is to hold the pattern at some distance from the lamp or candle, moving it at first rather slowly. I have described these appearances thus minutely because they serve, according to my observation, to produce the illusion in question: in them lies the whole mystery.

I conceive that the light and dark borders in the two figures have the same effect on the mind of the observer as the ordinary light and shadow seen on any prominent object that is illuminated from one side; and if such an object could be presented to our view with its light and shade shifting rapidly from one side of it to the other, though without its being moved, I believe we should have an impression that the object really was moving, because we know from experience that such an effect is only to be produced by shifting the position of the candle, or of the object illuminated by it.*

And so it is with the worsted patterns. When we see these spots with their light and dark borders shifting from side to side, we are led to infer that, as the lamp or candle is stationary, the spots themselves actually shift their position, and move faster than the ground of the pattern. Such at least is the illusion; and in some instances the spots will even appear like protuberant bodies rolling from side to side.

In order to prove that this change of tint at the edges of the figures is an efficient cause of the illusion, I prepared a small instrument on this principle. A blue and red spot were affixed to a white card in such a manner that movable shadows might be introduced behind them, which were made to slide from side to side in imitation of the borders of the worsted spots, and to persons not acquainted with the nature of the contrivance the effect was the same, the colored spots appeared to move when their shadows only were being moved.

On the other hand, when the formation of the light and dark borders is prevented, as may be done by inserting a row of white stitches round each of the spots, so as to separate the two colors, then the illusion ceases—the figures are no longer seen to move. The reason of this is obvious, that the presence of the white stitches is an obstacle to the blending of the colors on which the light and dark borders depend for their production. The difference of tint in the two cases may require some further explanation,—why the red spot has a dark border, and the blue a light one. The apparent blending of colors in a state of rapid motion is generally accounted for by the physiological fact, that the eye retains impressions for an appreciable time after the ob-

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* I have often convinced myself of the truth of this by a simple experiment. Some prominent body, as a white ball or cylinder, is suspended before an observer seated with his back to a table, on which two lighted candles are placed at some distance apart. By covering up each candle alternately, the light and shadow on the object may be reversed; and if this is done rapidly, it will give it the appearance of moving from side to side.

jects themselves are withdrawn from view; and when a number of objects are presented to the eye in quick succession, the image left on the retina by one object is liable to be confused by that of the succeeding object; and when these are of different colors, a compound color is perceived which is intermediate between the two; but as the spectrum left by the first object is fainter than the image of that which is actually present, it follows that the color of the latter will always predominate. Hence in the blending of the two colors which takes place at the junction of the spot and the ground of the pattern, the resulting tints are different in each case; for the red spot it is purple, that is, the margin of the red spot is seen through a blue spectrum, that of the ground,—while the border of the blue spot appears of a lavender tint, the blue being seen through the spectrum of the red ground. From experiments made with glass of different colors, I venture to suggest this as the probable explanation; for I find that red becomes darker by being seen through a medium of light blue, while the blue is rendered lighter by the aid of a red glass.

These effects are not to be confounded with the phenomenon of "accidental colors," in which the spectrum of an object is of the opposite or complementary color, these colors being produced only when the eye has been exerted upon an object for some considerable time; and, moreover, the complementary colors of blue and red are not perceived at all in these experiments. I mention this distinction, because an attempt has been made to explain the apparent motion of these figures by a reference to the theory of accidental colors.

It remains to be shown why blue and red are the only colors to exhibit this peculiarity. The only suggestion I have to make is, that the intermediate tints formed by the admixture of blue and red contrast strongly with both of the original colors, so as to produce the required effects of lights and shade; and certainly both purple and lavender form decided contrasts with blue and red. And this is not the case with any other combination of the primary colors. For example, the orange tints produced by blending red and yellow contrast too feebly with either of these colors for any effect of light and shade, and the same objection applies to blue and yellow.

Finally, why is the illusion seen only by artificial light? Not from the blue being seen as green (because some degree of motion is observable in blue and red patterns by daylight if they are examined in obscure corners), but from the indistinctness of artificial light as compared with solar light; for it will be found that if the colors are held close to a lamp or candle so as to be strongly illuminated; the effect is destroyed; and on the contrary, it becomes most striking in indistinct lights, as when the patterns are held under cover of the table on which the lamp stands, the shadows on the red spot then become exceedingly dark, while the light tints on the blue spot have almost a phosphorescent appearance. For the same reason, when the pattern is viewed indirectly, the effect is better than when the eye is directed full upon it; and in patterns composed of several spots or figures on their appropriate ground, it is remarked that the apparent motion is greatest in those parts on which the eye is not directed point blank, because our vision is then indistinct.

In connexion with this subject, I may mention another phenomenon equally curious and perplexing, to be observed with these same patterns. The blue spot, when viewed indirectly, always appears lighter than it really is; and when the eye turns full upon it, it resumes its proper color with a kind of start: the red spot again appears much darker by indirect vision, and becomes as suddenly light again when the eye is directed straight towards it. There is no doubt that these changes of tint serve to heighten the illusion of apparent motion when the eye is allowed to wander over the different parts of a complicated pattern. This phenomenon may perhaps be explained by the fact of the sight being most perfect in the axis of vision, or, as Sir David Brewster has expressed it, "the eye has the power of seeing objects with perfect distinctness only when it is directed straight upon them, so that all objects seen indirectly are seen indistinctly;" and it may be supposed that impressions received in those parts of the retina used in oblique vision are, as it were, diffused. Thus the red and blue spots, when viewed indirectly, appear tinged with the prevailing color of the ground of the pattern,—the red spot becoming darker by the influence of the blue round it, and the blue spot lighter by the vicinity of the red; for it is remarkable that this illusion is not produced with single colors, only with spots of one color surrounded by a field of the other.

In concluding these observations, I have only to add, that there cannot be much doubt of the correctness of the view which ascribes the illusory appearance of motion to the change of tint at the edges of the figures. These are matters of fact: but whether the theories offered in explanation of the facts are correct are not, I must leave to more competent observers to determine.

9. *The Tea Plantations in the N.W. Provinces of India, and the Culture of American Cotton in India*, (Jameson's Jour., July, 1848, vol. xlv, p. 191.)—In the Journal of the Agri-Horticultural Society of India, the leading article, which is also the longest and most valuable, is descriptive of the tea plantations in Kumaon and Gurhwal, and of the mode of manufacturing black and green teas. It is from the pen of Dr. Jameson, superintendent of the Botanic Gardens of Upper India, and is drawn up in the shape of a report to the Lieutenant-Governor of the N.W. Provinces. A clearly-detailed and well-arranged paper, we doubt not it will be perused with pleasure by all who take an interest in so important a culture. Apart from the satisfactory view it affords of what has hitherto been effected, it gives much useful information on many other points, and is therefore likely to prove a valuable guide to those who may hereafter be induced to carry out on an extended scale, the work in which the government are now acting the part of pioneers. We cannot undertake to give an abstract of this report, further than to mention, that the nurseries in Dr. Jameson's charge occupy altogether 162 acres, all under culture. Of these, rather more than 30 acres were added during last year. That, in addition to the plants reserved for manufacturing purposes, these nurseries have lately yielded two and a-half lac of seedlings, ready for transplanting at the time the report was furnished, and of which the greater part has been appropriated for the additional land selected in the Dherah Dhoon. A crore and upwards of seeds have again been sown, which will give a large additional

stock for transplanting. About twelve maunds of tea have been manufactured, both green and black varieties, from such plants as were of sufficient size for plucking. This, consequently, does not shew the total amount that 162 acres will yield; because, it must be remembered, that a tea shrub does not come into full bearing before the eighth year, and the oldest of these plantations were established, we believe, only eleven years since, while others have been added to, as mentioned above, during 1847. Perhaps this return scarcely gives one-twelfth of what the yield of nurseries of the present size will be when all the plants have arrived at maturity, seeing that an acre of land, covered with full-bearing plants, should yield a maund of tea in a manufactured state; and this, it is estimated, will not only pay the expense of cultivating, allowing the produce to yield three rupees a seer—by no means a high rate—but give a fair profit to compensate for the loss of interest on capital during the earlier period of their growth. The report gives full particulars regarding the mode of growing the plant, and the proper season for plucking and gathering leaves. The number of hands who are now being trained up in this department, and in that of manufacturing, will prove most useful auxiliaries to the European planter on a future, and, we trust, not distant day; his capital and energy, in combination with their skill and experience, will probably effect a change which can scarcely fail to prove beneficial to all concerned. The introduction of this culture will be the means of encouraging the settlement of Europeans; of throwing a large amount of capital into what is at present a poor country, adding thereby to the comfort of the population generally, especially the agricultural section; and of augmenting considerably the small sum at present yielded to the state, in the shape of revenue, by these hill provinces. Moreover, the advantages arising from the introduction into the markets of Upper India of a wholesome beverage, sufficiently cheap for the consumption of the middling classes of the native community, and for supply to the commissariat, for the use of our European soldiery, are too palpable to need demonstration. In this light alone, the experiments now in progress must be viewed with interest and pleasure. But it is not solely to the provinces of Kumaon and Gurhwal that we have to look. Further inspection has proved the capability of various other spots, immediately to the west of the Jumna, for the culture of this important staple. Moreover, we are informed that, during the present cold season, Dr. Jameson has not only selected many new sites in the Kangra valley, but commenced operations, by the despatch of several hundred thousands of seedlings. Besides this, the fact which we announced some time ago, that the Supreme Government had determined on the establishment of tea plantations along the whole of the mountainous part of the northwest frontier, from the Sutledj and the new country west of it to the Kali, coupled with the circumstance, that an annual grant of a lac of rupees has been lately authorized to carry them on in an efficient manner, prove that our rulers are fully alive to the importance of firmly establishing this culture in Upper India. Should these endeavors prove successful, and private skill and capital be employed hereafter to continue what the state has so happily begun, it is not going beyond the bounds of probability to expect, that, in the course of time, tea, the

produce of our own dominions, will not only compete successfully with that of China in the market of this metropolis, but add another to our list of export articles.

The next paper is contributed by Dr. Robert Wight, superintendent of the government cotton-farms in the Coimbatore District,—*On the Culture of the American Cotton in India, and the proper time for sowing it in various localities.* We had expected a longer and more elaborate paper on a subject of such importance; nevertheless, as the remarks of one having considerable experience of this staple, and possessing an intimate knowledge of physiological botany, we can scarcely doubt they will prove valuable to those engaged in a similar pursuit. Dr. Wight is of opinion, that in his district, as indeed throughout the western coast of the Peninsula, where the N.E. monsoon is usually of short duration, July is the most favorable time for sowing the Mexican variety; while August and September is the best season for localities along the eastern coast, the same monsoon being there of greater force, and extending over a longer period; and that as respects districts subject to the S.W. monsoon, "the last week of May and all June will probably be found the most suitable seasons, the exact time being determined by the individual season and average durations of the rains at each station."

Dr. Campbell, the superintendent of Darjeeling, communicates, in the third article, an experiment which he had instituted on the culture of the tea-plant at that sanatarium, and which promises a favorable result. He thinks it reasonable to expect quite as good tea to be produced there as at Kumaon, and in that opinion he is supported by Dr. Jameson. Darjeeling possesses an advantage over the Kumaon and Gurhwal provinces in point of elevation, being 7,000 feet above the sea. Dr. Campbell promises to report progress. We shall watch it with attention. The introduction of this valuable plant within so short a distance of the metropolis is a matter of no little interest, as connected with the extension of its cultivation.

10. *Expedition into Australia,* (Athenæum, Oct. 7.)—A new expedition into Northeastern Australia is projected for May next, to be under the direction of Mr. Kennedy. The region is called the York Peninsula, visited by Leichhardt, on his way to the Gulf of Carpentaria. Mr. Kennedy proceeds in the Tam O'Shanter to Rockingham Bay, in 18° S., and thence to travel by land to Princess Charlotte's Bay and Cape York, keeping the most convenient distance from the coast. Thence down to the east coast of Gulf of Carpentaria to the water Plaets, to ascertain whether that is the estuary of Leichhardt's river Mitchell, and if so, to follow it up to the junction of the Lynd. The expedition then goes W.S.W. to the river Flinders, for the purpose of ascertaining its source, and from it will attempt to connect the journey with Sir Thomas Mitchell's discoveries in 1846.

11. *Platinum.*—Platinum having been discovered in the Alps by M. Gueymard, the Conseil-General des Mines has authorized researches to be made in that part of the Alps which is on the frontiers of the Department of the Isère. From the nature of the soil, it is expected that deposits of platinum will be found in several localities.

12. *Mines in Australia*, (Adelaide Observer; Athenæum.)—The exports of lead and copper ores from South Australia for the past year (1847), have been declared in a semi-official Report at more than 180,000 pounds. The silver-lead mines of Glen Osmond are being vigorously and successfully prosecuted, and to the productiveness of the contiguous property of Wheal Watkins is about to be added a like productiveness of Wheal Gawler, also adjoining.

13. *The Nile*, (Athenæum.)—Dr. Bialloblotzky is about to undertake an exploring tour into the interior of Africa. His main object is to make one more attempt to settle the disputed geographical question of the position of the sources of the Nile. He was to leave Suez for Aden about the 23d of October, the East India Company having granted him a free passage in one of their steamers. The plan is to proceed from Aden to Mombás on the East Coast of Africa, in about 4° of South latitude, and there, or in its vicinity, make arrangements for travelling into the interior with a native caravan or otherwise. It is anticipated that a journey of 300 or 400 miles from the coast, in a direction between W. and N.W., will bring the traveller to the edge of the table land of Eastern Africa, at the water-parting between the basin of the Upper Nile and that of the rivers Lufídgi, Ozi (Pokomozi or Maro) and Sabaki, flowing eastward, into the Indian Ocean.

14. *A Cabinet of Minerals for sale, collected by the late Dr. Crawe, of Watertown, Jefferson Co., N. Y.*—The cabinet of minerals of the late Dr. Crawe, consists of rare and choice specimens, obtained in part by personal efforts, in part by exchange with gentlemen at home and abroad. It is particularly rich in the northern minerals of New York and Nova Scotia, and contains 1,000 specimens or more. It will be disposed of for a sum much less than its intrinsic value, and may be regarded as an object of moment to public institutions or individuals interested in this branch of science. Enquiries on the subject may be made of Dr. Emmons, of Albany, or Doct. Gray, of Harvard College, Cambridge.

[Although I have not seen the cabinet of the late Dr. Crawe, I have received from him so many and such excellent specimens, that I am well convinced his entire collection must be very valuable, especially in the local minerals of the region which he so faithfully explored.

His specimens of crystallized mica—of crystallized apatite or phosphate of lime, and of fluor spar, have no superiors in this country, nor the two former any equals as far as I know in any country.

Dr. Crawe's zeal for science cost him his life, and his widow and children have strong claims upon its cultivators and upon their country.

B. Silliman.]

Obituary.

15. William Oakes, A.M., well known as the most distinguished botanist of New England, fell overboard from the ferry boat between Boston and East Boston, and was drowned, on the 31st of July, 1848, at the age of forty-nine years. The services which Mr. Oakes has rendered to that department of natural science to which he was so enthusiastically devoted, his active kindness of heart and liberal spirit, which

endeared him to a wide circle of friends and correspondents,—no less than the painful circumstances of his death, in respect to which a misapprehension has obtained currency, which it is the duty of friendship to correct,—all conspire to claim a tribute to his memory in the pages of the American Journal of Science. The writer regrets that the materials at hand for a biographical notice of his lamented friend are so scanty. There are, no doubt, many interesting reminiscences which might be furnished by the surviving companions of his earlier years. But the life of the naturalist who, instead of gathering the novelties of far distant regions, consecrates himself to the assiduous and complete investigation of the flora and fauna of his native district, is seldom eventful. The story of the life of William Oakes may be told in few words. He was born at Danvers, Massachusetts, on the first of July, 1799. He received his earlier education in the common schools of his native town, with the exception of a few months passed, while preparing for college, under the tuition of the late Benjamin D. Oliver, Esq., then a practicing lawyer at Danvers. He entered Harvard College in the year 1816, and was graduated with credit in 1820. His fondness for natural history, which he brought with him to college, was developed under the instructions of the late Professor Peck, and his vacations, and probably no small portion of his time while in college, were given to those studies which were to form the favorite occupation of his life. After his graduation, he spent two years at Cambridge as a law student. The next year he studied in the office of the late Hon. L. Saltonstall, at Salem. On the completion of his professional studies, in January, 1824, he removed to Ipswich (where he resided until his decease), and commenced the practice of law. This, however, he entirely abandoned in the course of two or three years, and devoted himself, with characteristic ardor, to the more congenial pursuit of natural history in all its branches, and especially of botany, which was from the first his favorite department, and in which he was already a distinguished proficient.

Mr. Oakes, although interested in every department of the science, early restricted himself to New England as the particular field of his labors, and seldom, if ever, herborized beyond its limits. There is scarcely a New England plant that he has not collected with his own hands, and prepared an abundance of surpassingly excellent specimens, and also subjected to a critical examination in a fresh state, the results of which were carefully recorded for future use. As early as the year 1830, he had already explored the alpine region of the White Mountains of New Hampshire, in conjunction with his friend Dr. Pickering; and had projected a Flora of New England, to be arranged according to the Natural System, with a Linnæan artificial key to the genera. The appearance of Dr. Beck's Botany of the Northern States in 1833, upon a similar plan, caused him to abandon his own undertaking for a time; but he afterwards resumed the scheme with increased ardor and upon a more elaborate scale. All his explorations, and his special undertakings converged upon this, as the principal work of his life. Towards this he had unweariedly amassed an immense store of materials, and if his premature death has left them in a state which shows little progress made towards their final elaboration, this is to be attributed

not to any lack of industry or perseverance, but to a too fastidious taste, and an over anxious desire not merely to satisfy the ever increasing demands of the science, but to realize his own high standard of perfection. Indeed such were the characteristics of his mind in this respect, that he was never satisfied with any thing done as well as it reasonably could be at the time; and in consequence every piece of work that he undertook grew rapidly under his hands until it became well nigh impracticable. This infirmity, if such it may be deemed, is one with which every naturalist, who feels bound to do justice to his themes, can sympathise. It is but too well illustrated in Mr. Oakes's case by the particular undertaking which occupied his latest years, and from the midst of which he was so suddenly removed. In the autumn of 1842, he was solicited to prepare a brief sketch of the botany of the White Mountains, with a catalogue of their alpine plants, to be appended to the Final Report of the Geological Survey of the State of New Hampshire. Although he had repeatedly explored the mountains, and made their botany a special study in view of his projected New England Flora, he insisted upon visiting once more those favorite haunts before committing his remarks upon their botany to writing. The consequence was that new problems were presented much faster than they could be solved. The subject expanded in magnitude as it rose in interest. One exploration led to another, and a large part of every succeeding summer until the last, was untiringly devoted to these favorite investigations, and to the collection and preparation of literally *hundreds* of specimens, such as he alone could make, of nearly every species that inhabits those mountains, from the forest trees which cover their sombre slopes to the low alpine flowers and mosses that cushion their woodless summits, and the hoar rock-lichens that speckle their topmost crags. The space of a substantial volume was now requisite to do justice to the enticing subject; and the plan was enlarged accordingly. The Geology, Mineralogy and Zoology of the mountains claimed their share of attention; an excellent artist was employed in making drawings of characteristic plants, and finally of phytostatic views and illustrations of the scenery, of rare faithfulness and accuracy. As it became desirable to complete and publish these illustrations separately, in advance of the general work, to which they were at first intended as an appendage, but which they now threatened to overwhelm, Mr. Oakes devoted his attention and all his available resources to having them properly lithographed and published. After surmounting difficulties, one after another, which would have driven any less resolved man to utter despair, after cancelling plate after plate which did not fulfill his expectations, Mr. Oakes had just succeeded in completing them, had sent the last sheet of the text to the printer,—and moreover had just been perfectly relieved from a temporary pecuniary embarrassment in which it had involved him,—when, in a mysterious Providence, he was suddenly removed from the scene of his labors at the very moment they were crowned with success!

To detail the circumstances of the casualty by which a family circle was bereaved of a fond husband and father, while society lost an estimable member, science an ardent votary, and many a naturalist a warm and trusty friend, would not under ordinary circumstances be

either fitting or needful. But in this case, justice requires that his memory should be retrieved from the mistaken judgment of a hasty inquest, by a simple statement of the particulars of the melancholy occurrence, as they have been carefully collected by a friend of the deceased, and communicated to the writer of this notice. It appears, in brief, that Mr. Oakes had been unwell during the previous week; that he was occasionally subject to sudden attacks of vertigo; that he was indisposed and took no breakfast on the morning of the 31st, but left for Boston in an early train of cars to arrange some business there, and return if possible by the eleven o'clock train; that he was much exhausted by walking and by the heat of the day; that he stopped, only a few minutes before the starting of the ferry-boat, at a store near the head of the wharf leading to the depot, to purchase some shot for gunning; that, although he had but a few moments to spare, he took particular pains and trouble to select the two sizes of shot which he was accustomed to use, taking six pounds of one sort and four of another; that, the bell ringing while he was making his purchase, he hurried with it to the depot; that he there met the gentleman whom he came to Boston to see, and received from him the answer he had been led to expect in regard to a business transaction between them, and which precluded all pecuniary anxiety; that he hastily tied up his two packages of shot in his pocket handkerchief, hung it upon his arm, for convenient carriage, and stepped on board the boat just as it was leaving; that, soon after the boat was out of the dock, he was observed standing or sitting at the stern, which was unprotected by a barrier, and the next moment he was seen in the water, where he sank before any effectual means could be used for his rescue. Under these circumstances there is every reason for believing that, in his exhausted state, he was seized with sudden faintness or vertigo, and fell overboard from the stern of the boat; an accident which was the more likely to occur, from the fact that he was very heavy, and awkward in his movements.

It is manifest from what has already been remarked, that Mr. Oakes's services to American botany, are not to be measured by the amount of his actual publications. These consist, principally, of a *Catalogue of the Plants of Vermont*, contributed to the "History of Vermont, Natural, Civil, and Statistical," by Zadock Thompson; and of two or three articles contributed to Hovey's Horticultural Magazine, comprising descriptions of new plants of New England, or notices of new localities, detected by himself or his friend Dr. Robbins. These are but small indications of what he might have accomplished. But there are few botanists in this country who are not indebted to him, directly or indirectly, for some portion of their knowledge, or for some of the finest specimens in their herbaria; and there is no treatise, and scarcely an article on the botany of the Northern States, published within the last twenty years, to which he has not in some way essentially contributed. The immense collections of most beautiful specimens, which he made with peculiar skill, were never hoarded, but were freely bestowed upon every botanist, upon every amateur indeed, who desired, or who could appreciate them. When they accumulated in large quantities upon his hands, it was only because he was not yet prepared to distribute them in the form which seemed most fitting, nor yet able to

enhance their value as he wished, by perfectly authenticating their names. More than once has he placed interesting collections in the hands of the writer, for foreign distribution, perchance among strangers who had never heard his name, expecting no return, other than the satisfaction of knowing that they would be useful. When a botanist who then knew him only by a casual correspondence, lost his whole herbarium by fire, Mr. Oakes's prompt letter of sympathy was accompanied by the substantial encouragement of a fine package of plants, with which to commence the restoration, as well as with most cordial proffers of further assistance.

Mr. Tuckerman has consecrated to the name of Oakes, already inseparably connected with New England botany, a beautiful and highly interesting evergreen, newly detected in several localities along our eastern coast, (the OAKESIA CONRADI, *Tuckerm.*, which is finely figured in the volume of the Memoirs of the American Academy, now just published;) but even if that genus be superseded, his name will not perish from among us, nor the memory of his many virtues, of his active liberality, his manly and disinterested zeal, his untiring devotion to science, and his pure love to the objects of his study for their own sake. A. GR.

16. *Death of* ROBERT GILMOR, Esq., *of Baltimore.*—We cannot permit one of our earliest and most constant friends to pass away without a brief tribute to his memory. His death took place in Baltimore on the 30th of November, at the age of seventy-four or seventy-five.

Mr. Gilmor was one of the first to second and by his influence and kindness to sustain our efforts in those departments of science in which we have labored.

He early attached himself to the cultivation of mineralogy, and his affluence and extensive personal acquaintance with eminent mineralogists in Europe, and his travels in various foreign countries as well as his intimate intercourse with our rising mineralogists at home, enabled him to collect a cabinet remarkable for its richness in fine and rare minerals; for he selected his specimens with the spirit both of a man of science and of an amateur. The notice of his cabinet in our last number was communicated by himself, and the other treasures of his richly endowed mansion made it a beautiful museum for science, literature and the arts. His collection of autographs is distinguished not less by its extent than by its high value. Mr. Gilmor moved in the most elevated circles in Europe and had access to literary treasures, some of which are very peculiar. He was for many years a sufferer with the asthma, but his energetic and animated spirit, by God's blessing, sustained him to a good old age, cherished, admired, revered and beloved by a wide circle of friends. He was a fine example of a gentleman of the old school; polite, cheerful, frank, affectionate, hospitable, and liberal both with his money and his influence. He was a decided supporter of the religious and moral institutions of Christianity, and of all good and benevolent efforts.

His father, a native of Scotland, but long established in Baltimore, sustained and transmitted to his son a high standing as a merchant and banker. Louis Phillippe and his brothers drew their funds from this banking house when they left Baltimore on horseback for the west-

ern wilds,* and during their wanderings in America they referred to the house of Gilmor.

17. Dr. SAMUEL GUTHRIE, died near Sackets Harbor, on Thursday evening, Oct. 19, aged sixty-six. The deceased was endowed with intellectual powers of a high order, and was a devoted student of nature. He was eminent in his profession, while engaged in its practice; but for many years previous to his death, had been occupied with other pursuits. Being the original inventor of the percussion powder, and the only manufacturer of that article in the United States, much of his time had been employed in superintending its preparation—and while thus occupied, he had on several occasions narrowly escaped with his life, receiving severe injuries from which he never entirely recovered.

The honor of first procuring chloroform is shared by him in common with Soubeiran of France, and Liebig of Germany. These three chemists without any concert of action, or knowledge of each other, procured it about the same time. The question of absolute priority has not been conclusively established, but a committee of the Medico-Chirurgical Society, of Edinburgh, awarded to the deceased the credit of having first published an account of its therapeutical effects as a diffusible stimulus, in 1832.

A love of the natural sciences was predominant in his mind, and he eagerly perused whatever had reference to *facts*, and *demonstrations* as a basis; entertaining at the same time, a feeling bordering on disgust for mere *assumptions*, *conjectures* and *speculations*. Chemistry was his favorite study, and he is chiefly known to the scientific world through his contributions to this Journal,† and the "Scientific American;" while in connection with *Chloroform*, his name is familiar in both hemispheres.

His reading was varied and extensive; embracing nearly every department of knowledge and literature, except works of fiction, for which he had no taste. He was a constant and attentive reader of the medical periodicals of the day, and took a lively interest in everything pertaining to the progress or improvement of medical science. He had suffered severely from bodily infirmities for years, but his mental vigor continued to the last—and many who knew him, can bear testimony to the kindness of his disposition, and the generosity of his nature.—*Sackets Harbor Observer.*

18. Dr. A. GOLDFUSS.—The death of Dr. Goldfuss, the author of the great work on Fossils, has been recently announced. His age was 66.

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* As mentioned to the writer by Mr. Gilmor.

† The following is an enumeration of the articles contributed to this Journal by Mr. Guthrie:—

On a mode of obtaining chloric ether, volume xxi, 64, and xxii, 105.

Vaporization of Mercury in the fumes of Nitric Ether, vol. xxi, 90.

Chemical Products:—Manufacture of Chlorate of Potash and a percussion powder—Molasses from the Potato—Gunpowder—Pure Spirits of Turpentine, vol. xxi, pp. 92-94.

Sugar from Potato Starch, vol. xxi, p. 284.

Fulminating Preparations—Purification of Oil of Turpentine—Safe process for manufacturing Gunpowder—Fulminic acid and Fulminates, vol. xxi, pp. 288-295.

VI. Bibliography.

1. *The Sailor's Horn-Book for the Law of Storms*, being a Practical Exposition of the Theory of the law of Storms, and its uses to Mariners of All Classes in All Parts of the World, shown by Transparent Storm Cards, and Useful Lessons; by Henry Piddington, President of Marine Courts of Enquiry, Calcutta.—308 pp. 8vo, with 4 Maps, and 2 Horn-Cards.*—No work has appeared of late years, tending more to promote the interests of navigation and the welfare of seamen, than this volume by Mr. Piddington. It is written for practical men, in plain and forcible English, with full illustrations and directions, and with all the details required by the sailor in his voyages over the world. And if taken and carefully studied, it may be made a safe guide from the violence of gales and hurricanes, and prevent at least four-fifths of all the shipwrecks that happen in the open ocean. It teaches that hurricanes have their courses, and a certain regular system in their winds, and that while a prolonged storm, resulting perhaps in disaster, may await the ship that drives on without knowledge, a speedy escape is nearly certain, if one or two simple rules are regarded. Indeed the mere placing of a piece of horn marked with the requisite circles, upon a map over the position of the vessel, enables the sailor to see at a glance the course he must take to avoid the storm; and often he thus may even make its violence contribute to hasten him on his course.

The author observes in his Preface, "I know that many forget that a hurricane at sea is like 'a battle in a campaign;—an important though unfrequent occurrence for which it is wise to be well prepared;' and, rarely looking at works like the present till they want assistance from them, are thus very liable to mistakes in a moment of anxiety. If such however, will but give it one fair perusal at leisure, they may find perhaps—recollecting with quaint old Thomas Fuller, that 'the winds are not only wild in a storm, but even stark mad in a hurricane'—that a little study in fine weather may save a world of labor and mischief in bad."

This work therefore claims attention as an invaluable contribution to the interests of humanity as well as commerce. It teaches how to wield the storm, or avert its fury; and it is a work of benevolence to place this knowledge within the reach of those who are so often at the mercy literally of the winds and waves. No mate, much less captain, should be allowed, without a familiarity with the facts here detailed, to have the control of a ship and the lives it contains.

The introduction of new ideas will encounter prejudices. As Mr. Piddington mentions, even the variation of the compass was once written against as an absurdity, and Mercator's projection was pronounced as only fit for land-lubbers! "We must expect," he adds, "to find many 'of the old school' who 'do not like new-fangled notions,' many who 'do not like to be put out of their way,' many who 'think the old plan is good enough,' and that 'hit or miss, for luck's all,' is quite enough with a stout ship and a good crew; and to conclude, many who are too proud, too ignorant, or too indolent to take the trouble to learn. From such we can only entreat a patient hearing; and if, by chance,

* Published at Calcutta, and also by Wiley in New York.

they have lost a mast or two in a hurricane, quote to them the assurance of Poor Richard, that 'they that will not be counselled cannot be helped,' and further, that 'if you will not hear reason, she will assuredly rap your knuckles'—in the next hurricane."

The views entertained in Mr. Piddington's work are not novel to the American public;—or at least they ought not so to be: for they have been propounded and dwelt on at great length in this Journal, with abundant details and numerous illustrations. Here, in fact, they were first presented to the world. Mr. William C. Redfield, of New York, is the acknowledged author: severely and successfully has he labored, to ascertain the truth and make it useful to navigators. In his historical remarks, Mr. Piddington cites several authors of the past century, who had suggested that the violent storms at sea were rotary gales,* and then observes that—

"Up to the first ten years of the present century, all that appears known and published of tropical storms and hurricanes was that they were often great whirlwinds. Franklin had indeed shown in 1760, that the northeast storms of the American coast came from the S.W., but he did not prosecute the enquiry farther.

"Fortunately for science, however, Mr. William C. Redfield, of New York, had his attention drawn to the subject in the course of his professional pursuits as a Naval Architect, and in 1831 published in the 'American Journal of Science' a valuable paper, the first of a numerous series which has since followed, in which he demonstrated not only that the storms of the American coast were whirlwinds, but moreover that they were *progressive* whirlwinds moving forwards on curved tracks at a considerable rate, and were traceable from the West Indies and along the Coast of the United States till they curved off to the eastward between the Bermudas and the Banks of Newfoundland. He also gave many excellent practical rules for the management of ships, so as to avoid, or at least to diminish, the chances of damages from rotary storms, with valuable remarks on the barometer as a guide.†

"In an able article on the Law of Storms in the 'North American Review,' for April, 1844, is the following, which is not only part of the history of our science, but moreover a well merited tribute to the labors of the gentleman named in it—and I do not mean here to speak with less respect of those whose views have, I think, been proved erroneous. No one can have undertaken independent researches in any branch of the physical sciences without soon feeling that mankind owe much more than is usually supposed to those who have missed their road; they are the soldiers who have fallen, the successful are the victors who survive to reap the honors of the combat.

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* He mentions that Colonel Capper, in 1801, speaks of the Madras and Coromandel coast hurricanes as "whirlwinds whose diameter cannot be *more* than 120 miles, and the vortex seems generally near Madras or Pulicat."

† Mr. Redfield's papers in this Journal, are contained in volumes xx, 17; xxi, 191; xxv, 114, 122; xxviii, 154; xxxi, 115; xxxiii, 50; xxxv, 201; xxxvi, 50, 59; xli, 69; xlii, 112, 299; xliii, 250, 263; xliv, 384; xlv, 293; also in ii series, vol. i, 153, 333; ii, 162, 311.

"About the time that the American philosopher, Redfield, was employed in his earlier labors of observing and collecting the observations of others, a similar inquiry was in progress in Germany. On Christmas eve, 1821, after a long continuance of stormy weather, the barometer sank so low in Europe, that the attention of meteorologists was strongly drawn to the circumstance. M. Brande, having obtained the registers kept at this time in various places, came to the conclusion, that, during this storm, the winds blew from all points of the compass towards a central space, where the barometer was, for the moment, at its lowest stand. This conclusion was disputed by Professor Dove, of Berlin, who subjected the observations in the possession of Brande, as well as others, to a new examination, and made it appear, that an explanation of all the phenomena was afforded by the assumption of one or more great rotary currents, or whirlwinds, advancing from the southwest to the northeast.* Before this discussion was known in the United States, Mr. Redfield, by an independent course of investigation, had arrived at the result we have already announced, and his opinion is fortified by facts and cases so numerous and well authenticated, as fully to justify the distinction which Sir David Brewster has accorded to him in the following language,—'The theory of rotary storms was first suggested by Colonel Capper, but we must claim for Mr. Redfield the greater honor of having fully investigated the subject, and apparently established the theory upon an impregnable basis.'"†

"Mr. Redfield was followed in 1838 by Lieut. Col. Reid of the Royal Engineers, who published the valuable and well known work usually called 'Reid on the Law of Storms,' in which he not only fully confirmed Mr. Redfield's views, but added most extensively to the proofs of them, by investigations of the West Indian Hurricanes, and those of the Southern Indian Ocean, and moreover by proving farther what Redfield had already announced theoretically, that in the Southern Hemisphere the storms revolve in a contrary direction to those in the Northern one."

The work of Lieut. Col. Reid is a thick octavo volume, (436 pp.,) published in England, after an extended investigation of the Atlantic Storms, and a study also of those of the Southern hemisphere. The volume brought out the practical character of the principles, and contained rules for the direction of a ship when a storm is encountered. The researches of Mr. Redfield are detailed at length, and were the basis of the work.

In 1845, Dr. A. Thom, of H. M. 86th Regt., published a valuable work on the science generally, but more particularly relating to the Storms of the Mauritius and Southern India, presenting facts supporting the same theory as regards the rotary character of storms.

Mr. Piddington is not a mere collator of others' labors. On the contrary, his own investigations have been extensive, forming "a considerable portion, as to bulk at least, of the evidence new and corroborative upon which this science rests." More than this, they have brought to light much that was new as regards general truths. His memoirs, four-

* London and Edinburgh Journal of Science, Nos. 67, 68.
† Philosophical Magazine, vol. xviii, 3d series, p. 515.

teen in number, are published in the Journal of the Asiatic Society, volumes viii to xiv, and if collected together would make a volume of 650 pages, with 30 plates and diagrams.

The simplicity of his explanations and instructions, no less than the thoroughness of his work, evince the author's learning, acumen, and good judgment. We may dissent from one or two of his deductions, but these points, if incorrect, do not affect the practical value or interest of the work.

Mr. Piddington calls a great rotary storm or hurricane a *Cyclone*, a word derived from the Greek *κυκλος*, *circle*. After devoting twenty pages to an historical account of this branch of meterology, and a notice of different theories, he passes to Part II, in which he enters upon the descriptive and explanatory part of the subject. Considering the general principle well established, that the gales of the two hemispheres revolve in opposite directions, those of the southern *with* the hands of a watch, and those of the northern the reverse, he points out the several well ascertained tracks of gales over the globe, referring largely to facts and authorities, describes the general characters of storms in the different regions, and mentions the average rates and sizes of hurricanes in the various seas, and the peculiarities they present. We have not space to give an abstract of the work; neither is it necessary, as the volume may be had by all who desire to study the subject.

Part III, occupying pages 64 to 125, contains practical directions for avoiding storms and turning them to account.

Part IV, pp. 126 to 176, treats of previous phenomena attending storms; the storm wave and storm current; passage of the centre of storms; electrical or magnetic effects; arched squalls and tornados.

Part V, (the concluding 116 pages,) explains the value and uses of the barometer and sympiesometer, and the changes they indicate during gales: it treats also of the height of storms; signs of their approach; water spouts; formation and breaking up of hurricanes; besides other topics of interest.

The mode of using the storm cards will be gathered from Mr. Redfield's figures in this Journal, p. 333, vol. ii, 1846; for the circles marked on the cards are similar to the figures here referred to. They are, in fact, plans of hurricanes. Being made of transparent horn—for which idea we are indebted to Mr. Piddington—they are extremely convenient in use. If a vessel, for example, near the Bermudas, feels an approaching hurricane, and has the wind blowing southeast, the horn-card is laid on the chart, placing any point in that radius which corresponds to *wind S.E.* over the point marked for the *position* of the vessel. This being done, it is at once observed that the body of the cyclone is in this case off to the southwest; farther, that by running west, the vessel will be driving into the fiercest of the gale; by going north, she will also encounter its violence and prolong its continuance; by going southeast, she will dodge it entirely, or feel only its exterior winds. It is a fact previously known for these seas, that the gales have a course to the northward or northward and eastward. In the same manner, the cards may be used for other regions. Mr. Piddington's illustrations leave nothing to be desired in the way of fullness and simplicity.

We leave the work, again commending it strongly to all who own vessels on the ocean, as well as to those who command them, urging

that no ship be sent to sea without a barometer, and a good supply of copies of "The Sailor's Horn Book of Storms."

2. *Memoir, Geographical, Political and Commercial, on the Present State, Productive Resources and Capabilities of Siberia, Manchuria, and the Asiatic Islands of the Northern Pacific Ocean; and on the importance of opening Commercial Intercourse with those Countries, &c.* Addressed to his Excellency, JAMES K. POLK, President of the United States; by AARON H. PALMER, Counsellor of the Supreme Court of the United States, &c. March 8, 1848. Referred to the Committee on the Library and ordered to be printed. 106 pp. 8vo.—The author of this Memoir has embodied in a few condensed pages, a large amount of information on the countries of which he treats, and urges with arguments meriting attention, the importance of opening commercial intercourse with regions yet unvisited, and revising the arrangements existing with other distant nations. He suggests the importance of an early revision of our commercial convention with Russia of the $\frac{5}{17}$th April, 1824, for the admission of our vessels into the ports of Siberia, Kamschatka, the Kurile and Aleutian Islands, and the North Pacific, as well as the Russian settlements of Northwestern America. He observes that it is "equally important that our government should insist on the right of navigating the great Manchurian river Amúr and its affluents, and of trading with the colonial dependencies of China, upon the same footing as the Russians; and that we claim the further privilege of commercial intercourse at Tinghae, in the Chusan Archipelago. The favorable position of that port, with its safe anchorages, accessible to the largest ships at all seasons, lying near the embouchure of the great Yangtsekang river, and within two days' sail of Japan and Corea, give it superior advantages over every other port in China for trade, and as a depot and halting station for the American trans-Pacific line of steamers, which it is contemplated to establish between Panama and China, in connexion with the line now in progress from Panama to Oregon."

The Memoir is an extract, as Mr. Palmer states, from a work entitled "The Unknown Countries of the East," which he proposes to publish. The extensive geographical learning of its author, and his wide reach of mind, must render the work one of high value both commercially and geographically. From the Prospectus, we learn that it embraces descriptions of the features and resources of Ascension Island, St. Helena, Colony of the Cape of Good Hope—East Coast of Africa—Zanguebar—Comoro Islands—Island of Madagascar—Mauritius—Bourbon—Abyssinia—Red Sea—Ports on the African Coast—Arabia—Persia—Belouchistan, Sinde, Punjaub, Afghanistan—Hindostan—Burman Provinces—various islands of the Indian Archipelago, with an account of the steam communication between England, Singapore and Australia—North and Northeast coasts of Australia—Loochoo, and Bonin Islands, Japan, Kuriles, Yeso, Saghalien and other islands east of Asia—Manchuria and other Colonial Dependencies of China—Siberia, and the Russian Trade with China at Kiatka. An appendix includes memoirs on the steam navigation of the Pacific—on a ship canal from the Atlantic to the Pacific—a proposed mission to the East, and Consular plan for a portion of the countries described—with a catalogue of the authors consulted in preparing the work.

3. *Memoirs of the American Academy of Arts and Sciences*, New Series. Vol. III. Cambridge and Boston: Metcalf & Co., Printers to the University. 4to, pp. lxxxii and 290, with 45 plates.—The appearance of this volume, filled as it is with substantial and important contributions to science, is a gratifying proof of the efficient condition of this long established Academy.

The eloquent and discriminating eulogy on Hon. John Pickering, LL.D., President of the Academy, by Judge White, forms an appropriate introduction to the volume. Mr. Pickering was a noble example of the Christian philosopher—eminent alike in all that could adorn the scholar, the jurist, and the man of science. Judge White's eulogy upon this great and good man has been extensively read in the form in which it appeared soon after its delivery in October, 1846. It now for the first time, takes its appropriate place in the Memoirs of the Academy. It is followed by—

I. Chloris Boreali-Americana: Illustrations of new, rare or otherwise interesting North American plants, selected chiefly from those recently brought into cultivation at the Botanic Garden of Harvard University, Cambridge. By Asa Gray, M.D. Decade I, (with 10 plates.) p. 1.

II. Contributions to the Bryology and Hepaticology of North America. By William S. Sullivant, A.M. Part I, (with 5 plates.) p. 57.

III. Occultations and Eclipses observed at Dorchester and Cambridge, Massachusetts, by William Cranch Bond, Director of the Observatory, Wm. C, Bond, Jr., and George P. Bond. p. 67.

IV. An account of the Nebula in Andromeda. By George P. Bond, Assistant at the Cambridge Observatory, (with 1 plate.) p. 75.

V. Description of the Nebula about the Star θ Orionis. By Wm. Cranch Bond, Director of the Cambridge Observatory, (with 1 plate.) p. 87.

VI. Some Methods of Computing the ratio of the distances of a Comet from the Earth. By George P. Bond, Assistant at the Cambridge Observatory. p. 97.

VII. An Attempt to discriminate and describe the animals that made the Fossil Footmarks of the United States, and especially of New England. By Edward Hitchcock, D.D., LL.D., President of Amherst College, etc., (with 24 plates.) p. 129.

VIII. On Platygonus compressus: a new Fossil Pachyderm. By John L. LeConte, M.D., (with 4 plates.) p. 257.

Appendix.—Report on the discovery and Nomenclature of the Eighth Satellite of Saturn. By Edward Everett, LL.D. p. 275.

This volume is brought out with all the mechanical attractions of good paper and perspicuous type, and the plates are many of them very beautiful, especially the botanical and astronomical ones.

It is very gratifying to observe the impulse which this Society has received within the last few years—an impulse which reacts strongly to concentrate and render available the scientific research of New England especially. At no former period has the effective scientific force of the New England metropolis and her venerable University been so great or so active as at present.

The discovery of the new Satellite of Saturn, Hyperion, by Mr. George P. Bond, has already been noticed by us. The near coin-

cidence in the discovery of this satellite by Mr. Bond, at Cambridge, and by M. Lassell, at Starfield near Liverpool, England, (the first on the 16th, and the second on the 18th of September,) leaves to each the credit of an original discoverer, although the honor of priority plainly belongs to Mr. Bond. We are informed in this Appendix, that Mr. Bond is preparing a memoir to be presented to the Academy at a future day, containing in full the observations of Saturn, his rings, and satellites, made at the Observatory in Cambridge during the past year.

4. *An Elementary Treatise of Spherical Geometry and Trigonometry;* by ANTHONY D. STANLEY, A.M., Prof. of Mathematics in Yale College. 122 pp. 12mo. New Haven, 1848. We may commend this Treatise to the various institutions of our land, as an excellent manual for instruction in spherics. The definitions are clear and direct, and the demonstrations extend over as wide a range as can be desired for the general student. The first 54 pages are occupied with spherical geometry, and the remainder with spherical trigonometry.

5. *The Philosophy of Geology;* by A. C. G. JOBERT, late editor of the 'Journal de Geologie,' one of the authors of 'Recherches sur les Ossemens Fossiles du Puy-de-Dôme.' 2d ed. 184 pp. 18mo. *London* and *Paris.* 1847.—Also, *Ideas or Outlines of a new System of Philosophy;* by A. C. G. JOBERT, &c. 141 pp. 18mo, *London.* 1848.—Mr. Jobert in his Philosophy of Geology, commences by combating the doctrine of the eternity of the actual course of nature, and the view that the idea of a cause is based on the invariability of an antecedent and its consequent. He discusses and rejects the Huttonian dogma that the granitic material of our globe is but a re-fusion of previous rock-material, a theory which implies an eternity of causation. The author proceeds to a course of argument with reference to the relations and origin of the various strata of the globe; and although we cannot agree with him in all his steps, we fully assent to the result of the whole—that the phenomena of existences are not the consequence of an eternal law of invariable revolutions, but the acts of a Supreme Providence, who has directed matter in its transformations, and left, from period to period, visible traces of his power, his solicitude, and his munificence. The Second work on Ideas, continues the same topic, being an examination of the natural and philosophical ground of the idea of a God.

6. *Observations on Belemnites and other Fossil Remains of Cephalopoda, discovered by Mr.* REGINALD NEVILLE MANTELL, C.E., in the Oxford clay near Trowbridge, in Wiltshire; by GIDEON ALGERNON MANTELL, Esq., LL.D., F.R.S., F.L.S., and Vice President of the Geological Society.—This memoir, containing eleven pages, is published in the Philosophical Transactions, Part II, for 1848, and is illustrated by three quarto lithographic plates. Much light is here thrown upon the structure of the animal of the Belemnite, now known to be a cephalopodous mollusc. It is almost unnecessary to say that the memoir is characterized by the well known ability and accuracy of the distinguished author.

7. *A Memoir on the Structure of the Maxillary and Dental organs of the Iguanodon;* by G. A. MANTELL, &c.—This memoir is also from the Philosophical Transactions for 1848, Part II. It occupies ten pages, with four lithographic plates, one of which is folded and

presents a fac-simile both for size and form of the portion of the lower jaw of the Iguanodon, which is the principal subject of the memoir. An abstract is given in our last number, vol. vi, p. 429.

8. *A Memoir on the Dinornis*, Part III, containing a description of the skull and beak of that genus, and of the same characteristic parts of the *Palapteryx*, and of two other genera of birds, *Notornis* and *Nestor;* forming part of an extensive series of Ornithic remains, discovered by Mr. Walter Mantell, at Waingongoro, North Island of New Zealand; by Professor Owen, F.R.S., F.Z.S., &c. &c., pages 33, with five quarto lithographic plates.—We have barely room at this time, to announce the appearance of this memoir. The great interest of the New Zealand fossils renders these among the most important of the valuable labors of Professor Owen.

9. *Collections of the Georgia Historical Society*, Vol. III, Part I.—A spirit of enquiry has been growing more and more active for some time, regarding the history of the different States of the American Union, and we have perused with satisfaction the previous volumes published by the Georgia Historical Society, which have thrown great light upon the history of that state.

The present publication consists chiefly of the papers of the late Col. Hawkins, long known as a successful agent among the Indians of the southern part of the continent, with whom he had great influence.

We are much impressed by the picture which these documents present, of numerous Indian settlements existing at the close of the last and the beginning of the present century, in many places in the higher regions of Georgia; settlements marked by considerable advances in civilization, and in the means and habits of regular and comfortable living, with dawning institutions for civil government and instruction.

How great the change in fifty years! A stern policy has removed the remnants of these tribes beyond the Mississippi. It is still to be hoped that they may be redeemed from the habits of savage life and elevated to the standard of civilized and Christian nations.

10. *Memoirs read before the American Association for the Promotion of Science.*—The following memoirs by Mr. James Hall, were not included in the list given on page 393, of last volume.

I. On the tracks or trails in sandstone of the Clinton Group, of New York, indicating the existence of beaches and the frequent alternation of beds thus marked, proving the occurrence of tides. [?]

II. On some bivalve shells of large size from the Onondaga Salt Group. These shells are interesting, from being closely allied to Devonian types—Ex. Megalodon.

III. On the petrifaction of the soft parts of the Orthoceras and other shells.

D. P. Gardner: Medical Chemistry, for the use of Students and the Profession, being a Manual of the science, with its applications to Toxicology, Physiology, Therapeutics, Hygiene; by D. P. Gardner, M.D., formerly Professor of Chemistry in the Philadelphia College, &c. &c. pp. 396, large 12mo, with numerous wood-cuts.

James Hall: Address delivered at the Anniversary Meeting of the Harvard Natural History Society, May 24, 1848, by James Hall, Geologist and Palæontologist of the Geological Survey of the State of New York. 40 pp. 8vo. *Cambridge*, 1848.

C. B. Adams: Third Annual Report on the Geology of Vermont. 32 pp. 8vo. *Burlington*, 1847.

F. S. Holmes: Notes on the Geology of Charleston, S. C., 18 pp. 8vo.—A valuable memoir on the post-pliocene and tertiary and general features of the country about Charleston, South Carolina.

R. D. Thomson, M.D., of Glasgow: School Chemistry, or Practical Rudiments of the Science. fcp. 8vo.

J. H. Coffin: Elements of Conic Sections and Analytical Geometry. 158 pp. 8vo. *New York*, 1848. Collins & Brother.

W. J. Simmonite: Medical Botany. 12mo. *London*, 1848. 3*s.* cl.

Report from the Acting Secretary of the Treasury, communicating the Annual Report of the Commissioner of the General Land Office; with Reports of the Surveyor General accompanying the Annual Report; also Preliminary Reports containing outlines of the progress of the Geological Survey of Wisconsin and Iowa, up to October 11, 1847, by D. D. Owen and C. T. Jackson, and the Assistants in the Survey, Dr. Locke, Dr. Wm. F. Channing and J. D. Whitney. Senate Executive Document, No. 2, 30th Congress, 1st Session.

H. R. Schinz: Monographien der Säugethiere, mit Abbildungen von J. Kull. Heft 18, *Zurich*, 1848. Kl. Fol. 6 Tfln. ill.

J. H. Hasskarl: Plantæ javanicæ rariores, adjectis nonnullis exoticis in Javæ hortis cultis, descriptæ; 8vo, 554 pp. *Berolini* apud Förstner, 1848.

Jules Marcou: Recherches geologiques sur Le Jura Salinois;—From the Transactions of the Geological Society of France. Read before the Society in May and November, 1846. 151 pp. 4to, with maps.

J. C. Maly: Enumeratio plantarum phanerogamicarum Imperii Austriaci universi. *Vindobonæ* (Vienna) Braumäller u. Seidel.

C. Ch. Beinert: Der Meteorit von Braunau, am 14 Juli, 1847. 3 taf. Breslau, Trewendt in Comm.

O. B. Kuhn: System der anorganischen Chemie als Leitfaden zum Studium der theoret. Chemie bearb. *Göttingen*, Vandenhoeck u. Ruprecht.

H. Burmeister: Geschichte der Schöpfung, eine Darstellung des Entwicklung-Ganges der Erde und ihrer Bewohner. 3 Aufl. mit 228 Holzschnitten. 8vo. *Leipzig*, 1848.

Annales des Sciences Naturelles, Tome ix, 3e Ser. MARCH, 1848.—On the structure of the liver of Vertebrata (continued); N. Guillot.—On the Organization of Gasteropoda, order "Opisthobranches"; E. Blanchard.—New genus of Decapadous Crustacea; M. Edwards.—Mycological fragments (continued); J. H. Léveillé.—New or little known Eryngia; J. Gray.—On a new genus of Orobancheæ; E. Cosson.—On the Droseraceæ (continued); J. E. Planchon.—APRIL. New species of Sorex from Madagascar; Ch. Coquerel.—Metamorphosis of Brachyopa bicolor; L. Dufour.—Ibid, Cheilosia ærea; L. Dufour.—On genus Macrodontia, family Prionidæ; E. Blanchard.—Researches on Zoophytes ("Les Polypiers") 2d memoir; M. Edwards and J. Haime.—Monograph of the Turbinolidæ.—On the Droseraceæ (continued); J. E. Planchon.—Morphological and physiological observations on some species of cultivated gourd; G. Gasparrini.—New genus of Cucurbitaceæ, proposed; G. Gasparrini.—Anatomy and organogeny of Trapa natans; F. M. Barnéoud.—Mycological fragments (continued); J. H. Léveillé.—MAY. Researches on Zoophytes ("Les Polypiers"); M. Edwards.—Mycological fragments (continued); J. H. Léveillé.—Floral organogeny and embryogeny of the Nyctagineæ; P. Duchartre.—On the Droseraceæ (continued); J. E. Planchon.—New species of Plants.

Korrespondenz-Blatt des zoologisch-mineralogischen Vereins in Regensburg. *Regensburg*. 8vo. 1847. No. I–VI, S. 1–80, [1 fl. 48 kr.]—Geognostische Verhältnisse der Umgegend von *Passau* und des *Baierischen Waldes* oder des *Böhmer-Gebirges*: 29–32, 44–48; *Wallt.*—Notitz über ein merkürdiges Lager fossiler Pflanzen bei *Culmbach*: 32.—Das Vorkommen des Magnet-Eisensteins im Übergangs-Gebirge in *Böhmen*: 36–41; *J. Micksch.*—Fährten von Chirotherium Barthii u. A. im Bundsandstein bei *Culmbach*: 50.—Vorkommen des Retinasphaltes und des Bleiglanzes in der Steinkohlen-Formation von *Pilsen*, nebst einer geognostischen Skizze. 70–80. Tf. I; *J. Micksch.* (Neues Jahrb. of Leonhard and Bronn.)

Nyt Magazis for Naturvidenskaberne. etc. *Christiania*. 8vo. 1846. V, I, S, 1–88, Tf. I. in fol.—Versuch einer geognostisch-mineralogischen Beschreibung der Kobalt-Gruben bei *Modum*, mit Karte: S. 1–32; *K. F. Böbert.*—Gesetze für die Fortpflanzung des Lichts in isophanen und einachsig krystallisirten Körpern: S. 48–88. (Neues Jahrb. of Leonhard and Bronn.)

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ERRATA.

In our last number, (p. 425, and 462 index,) the name of Prof. Webster of Cambridge, should be J. W. instead of J. H Webster.

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. X.—*Some New Discoveries respecting the Dates on the great Calendar Stone of the Ancient Mexicans, with Observations on the Mexican Cycle of Fifty-two Years;* by E. G. SQUIER, New York.

THE most interesting monument of antiquity which has been discovered in America, is unquestionably the great Calendar Stone of the Aztecs, which now occupies a place in the walls of the Cathedral of the city of Mexico. It is an immense mass of porphyry, estimated to have weighed originally upwards of thirty tons. Its horizontal face is inscribed with a circle in relief, within which is found a complication of signs and figures, chiefly of an astronomical character, and referring to the motions of the sun. The relative positions and dependencies of these signs cannot be indicated without the aid of an engraving. I shall therefore, without going into a particular account of the stone,—involving, as it necessarily would, a complete analysis of the Aztec Calendar,—simply call attention to some of the results which have attended its study by Gama, Humboldt, Gallatin and others, so as to be able to submit, in a comprehensible manner, some additional discoveries which have followed its investigation, under more favorable circumstances.

The authorities above named, ascertained the existence of five signs upon this stone, referring to the principal annual positions of the sun, viz: the dates of the two transits of the sun by the zenith of Mexico, the dates of the vernal and autumnal equinoxes, and the date of the summer solstice. The summer solstice, according to the stone, occurred on the 22d of June; the

transits on the 22d of May and the 26th of July, and the equinoxes on the 22d of March and the 22d of September. This arrangement, it will be seen, gives 184 days from the vernal to the autumnal, and 181 from the autumnal to the vernal equinox, which, as observed by Mr. Gallatin, "although not strictly correct, shows that the Aztecs had ascertained by observation that the Sun remained longer North than South of the Equator, which is true, since its apparent motion is not uniform, but is accelerated during the time it appears south of the equator."* The transits of the sun, by the zenith of Mexico, were calculated by Gama and found to coincide with the dates engraved on the stone,—demonstrating that the observations which led to the original discovery of the true date were made in Mexico, and indicating that the astronomical knowledge of the Mexicans was of American origin.

These authorities also, from analogy and a consideration of a variety of circumstances which it is unnecessary to recapitulate, arrived at the conclusion that "the winter solstice corresponded with our 22d of December or very near it." None of them were however, able to detect the date of this solstice upon the stone. The supposed deficiency was accounted for, hypothetically, upon the assumption that the dates on the Calendar were calculated only for half of the year, viz: from the vernal to the autumnal equinox. There is nothing however, on which to ground this assumption, but the very deficiency, for which it was intended to account.

The difficulty, in the way of the satisfactory elucidation of the matter, has been the imperfect character of the engraved copy of the stone upon which the investigations of these scholars were founded. Until recently there has been but one drawing in existence, viz: the one which accompanies Gama's work upon the Mexican Calendar. This was reproduced by Humboldt in his "Researches," and is the same which was consulted by himself and Mr. Gallatin in their enquiries. Within a few years, a larger and very beautiful drawing has been made from the original, by M. Nebel, which is inserted in his splendid work on Mexico. This drawing, while it attests the general accuracy of that published by Gama, has enabled me to detect a most important error in the latter, and to clear up the doubt which has heretofore existed as to the date assigned by the Aztecs to the winter solstice.

The central figure upon the Calendar Stone is a symbolical representation of the sun, with protruding tongue, indicating life,—*to talk* among the Aztecs conveying the same idea of

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* "Notes on the semi-civilized Nations of America," Trans. Am. Ethnological Society, vol. i, p. 101; Humboldt's Researches, vol. i, p. 293.

vitality with *to breathe* in our own language, and *to eat* and *to walk*, in those of different stocks. The forehead of this figure is bound with a fillet, upon which, in Gama's drawing, is represented a group of unmeaning ornaments. In place of these, we have, in M. Nebel's copy, the distinct sign of 2 *Acatl.* Above it is an indicating ray, which points to the sign of the year 13 *Acatl*, for which year most of the engraved calculations seem to have been made. The day 2 *Acatl* for year 13 *Acatl*, (which is the 26th of the Aztec cycle,) *coincides with our* 21*st of December*, and is undoubtedly the hitherto undetermined date of the winter solstice, in the Mexican Calendar.

Fig. 1.

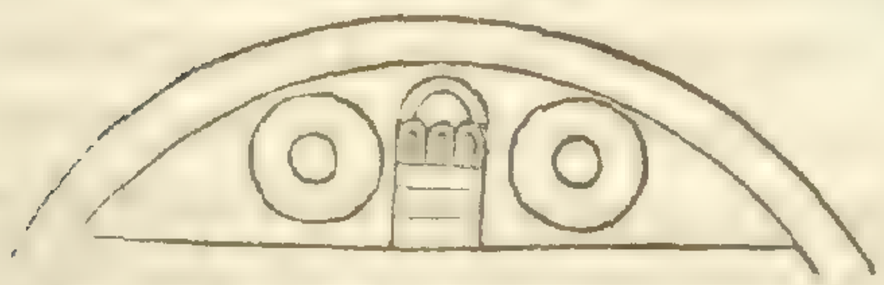

Fig. 2.

Fig. 1, of the accompanying engraving of the sign in question, is from Gama's drawing; Fig. 2, from Nebel's. *Acatl* signifies *a reed.* The central figure, of the second engraving, is a very common form of this sign, both in the paintings and on the monuments. It will be at once seen that the figures presented by Gama could not by any possibility be supposed to represent 2 *Acatl*, and hence the deficiency remarked by the illustrious investigators above named.

This discovery verifies the correctness of Gama's Analysis of the Aztec Calendar, at the same time that it furnishes us with an explication of certain religious observances, of a very remarkable character, prescribed, at fixed intervals, by the Aztec ritual.

The civil year of the ancient Mexicans was a solar year of three hundred and sixty days made up of eighteen months of twenty days each. To these were yearly added five complementary days, called *Nemontemi* or "*dead days*," which were deemed unlucky, and during which all religious observances were suspended. They were not counted as belonging to the year, but fell between the end of one year and the commencement of another. Four periods (*Tlalpilli*) of thirteen years each, made a cycle (*Xiuhmolpilli*) of fifty-two years. It will be seen that the fractional part of a day, which in our calendar is provided for by the intercalation of one day every fourth year, would in the course of fifty-two years, amount to *thirteen* days. That number of days was accordingly intercalated at the end of every cycle, so that each cycle commenced and ended upon corresponding days. Gama determined that the first year of the cycle (which was always *one Tochtli*) commenced on a day corresponding with our 9th of January. On account of the different modes of intercalation, it will be at once evident that, as compared with ours, the Mexi-

can year receded one day with every fourth revolution. So that the fifth year of the cycle commenced on a day corresponding with our 8th of January; the ninth year on a day corresponding with the 7th of that month, etc. By this constant recession, the last year of the cycle commenced on a day corresponding with our 26th of December, and consequently (deducting the five "*dead days*") must have terminated on the 21st of December, the precise date, as we have already seen, of the winter solstice.

This then may be laid down as the rule, in the scheme of the Aztecs. *That the cycle terminated when the last day of the year coincided with the date of the winter solstice.* And when we consider the influence which such a conjunction would be likely to have in a system with which the superstitions of the Aztecs were so closely interwoven, we shall be less disposed to look for the reason which determined the selection of the number of years constituting the cycle, in its multiples, however singular their combinations, than in the circumstance of the very conjunction here named.

No doubt a close dependence, I am not prepared to say how intimate, existed between this conjunction and the great secular festival of the Aztecs, celebrated at the end of every cycle. They believed that at the termination of one of these periods, the sun would never return, and the end of the world take place. This belief which was common to most primitive nations addicted to Sabianism, was, as observed by Humboldt, in the case of the Mexicans, "connected with the Toltic tradition of four *suns* or *ages*, at which periods the earth had undergone four great revolutions." Three of these destructions had taken place, according to the traditions, at the ends of cycles. At the end of each cycle therefore the deepest consternation prevailed. The five supplementary days were pas ed in great fear. On the fifth, the fires in the temples and houses were extinguished, the household utensils broken, garments rent, and whatever was deemed most precious destroyed. On the evening of this day, the priests dressed in the robes of the gods, followed by an immense procession of the people, went in solemn silence to the top of a high mountain near the city of Mexico, there to attempt the lighting of the new fire. The success of the attempt was an evidence of safety and of the benevolence of the gods. The fire was lighted, at midnight, by friction, upon the breast of a human victim sacrificed for the occasion. A great fire was then built and the sacred flame again distributed to the temples and houses. When the blaze was seen by the anxious spectators, the most extravagant joy was manifested, which was much augmented when the sun itself arose on the following morning, dissipating all fears with its effulgence.

The existence of this superstition, joined to the circumstance of the year terminating at a time when the recession of the sun was greatest, may have invested this period with so much importance as to make it a chronological era, from whence to date the years anew. However this may be, the conjunctions here noticed offer a better explanation of the singular selection of fifty-two years for the cycle, than is furnished by any analysis of the multiples of which that number is made up. It is not impossible however, that the further circumstance that the sacred numbers four and thirteen were multiples of fifty-two, may have had a secondary weight in the length of the cycle.

Passing by this question, we find that the discovery of the missing date of the winter solstice completes the circle of the sun's principal positions, as engraved upon the great Calendar Stone—a monument which still furnishes an interesting object of study, and the full understanding of which would no doubt tend greatly to increase our estimate of the astronomical knowledge and the ingenuity of the aboriginal Mexicans.

Note.—The apprehension of the extinguishment of the sun, at the winter solstice, is mentioned by Humboldt as affording a striking instance of the analogy which existed between the superstitions and religious observances of the ancient Mexicans, and the primitive nations of the old world. "When the Egyptians," says Achilles Tatius, "saw the sun descend from the Crab towards Capricorn, and the days gradually diminish, they were accustomed to sorrow from the apprehension that the sun was to abandon them entirely. This Epocha coincided with the festival of Isis: but when the orb began to reappear, and the days grew longer, they robed themselves in white garments, and crowned themselves with flowers."—*Humboldt's Res.*, vol. i, p. 383.

Art. XI.—*On the Comparative Value of different Kinds of Coal for the purpose of Illumination; and on Methods not hitherto practised for ascertaining the Value of the Gases they afford;* by Andrew Fyfe, M.D., F.R.S.E., F.R.S.S.A., Professor of Chemistry, King's College University, Aberdeen, &c. Read before the Royal Scottish Society of Arts.

(Continued from page 86.)

In the preceding part of this paper, I have shewn that gases from different coals not only require different times for the consumption of equal volumes, but that for these consumptions different pressures are necessary. It is of importance, therefore, to ascertain whether the consumption and the pressure bear the same ratio to each other, when different gases are used, that they do

when the same gas is employed. The consumption of gases, in some of the towns in England that I have visited, along with the pressure, was as follows,—the gases having been consumed from the same burner, and with the same height of flame :—

Gases.	Time for consumption of cubic foot by metre.	Pressure at burner in 100ths of inch	Square roots of pressures.	Time calculated by square root of pressure.	Difference between observed and calculated time.
	′ ″			′ ″	′ ″
Newcastle	50 30	11	3·31	. . . .	. . . .
Leeds	55 55	9	3	55 40	0 15
Liverpool	57 0	8·5	2·92	57 6	0 6
Manchester . . .	52 30	9	3	55 40	3 10

The following table gives the results with gases from Scottish parrot coal :—

Gases.	Time for consumption of cubic foot by metre.	Pressure at burner in 100ths of inch.	Square roots of pressures.	Time calculated by square root of pressure.	Difference between observed and calculated time.
	′ ″			′ ″	′ ″
Leshmahago,	85 0	42	6480	. . . .	. . . .
A.	59 20	80	8944	61 30	2 10
B.	69 5	64	8000	68 42	0 23
C.	65 50	72	8485	66 0	0 10
D.	90 50	38	6164	89 20	1 30

In the above tables, the experimental results agree very nearly with those given by calculation ; and, accordingly, we may consider the consumption of different gases, from similar burners, and under similar circumstances, to be as *the square roots of the pressures* necessary to burn them, under these circumstances; of course, the times required for the consumption of equal volumes will be *inversely as the roots of the pressures.*

Another important circumstance still remains to be ascertained, viz., as the pressure necessary for the consumption of gases varies, and as the consumption also varies with the specific gravity, Is there any connection between the specific gravity of different gases and the pressures necessary for their consumption, under similar circumstances?

The following table gives the results of the consumption of gases under similar circumstances, along with the pressures and the specific gravities, taken in the usual way.

Gases.	Pressure in 100ths of inch.	Square roots of pressures.	Specific gravity by experiment.	Specific gravity calculated by square root of pressure.	Difference between experim'ntal and calculated specific gravity.
E, ...	68	8246	580·6	. . .	. . .
F, ...	47	6855	697·6	698	0·4
G, ...	110	10488	458	460	2·0
Average of H, I, K, L, M, N, O, P, Q, R, S,	42	6480	732	738	6·0

The results, by experiment and by calculation, above given, so very nearly correspond with one another, that I think we are

warranted in concluding, that the pressure corresponds with the specific gravity, and that consequently the specific gravity may be ascertained by the pressure, when the gases are consumed under similar circumstances; having of course previously determined the specific gravity of a gas known to require a certain pressure for its consumption. Consequently the specific gravities being ascertained experimentally, the consumptions may be known; these being, *the times for equal consumptions, as the roots of the specific gravities*, and *the consumptions in equal times, inversely as these roots.*

Having established these positions, the next object I had in view was to ascertain, by a more extended series of trials, whether an indication of the consumption of gases, in different places, could thus be obtained, without having recourse to a metre, which, to an experimenter, carrying one from place to place, is troublesome. It at first occurred to me that this might be done by ascertaining the specific gravity; but this also must be a troublesome process, and unless ascertained with accuracy, would not tend to accurate results, especially in a hurried visit to different gas-works, where the height of the barometer cannot always be observed. After numerous trials, I at last determined to have recourse to the pressure-gauge, consuming the gas with a given height of flame, and always from the same burner. For this purpose, I used in my first trials the platinum-jet formerly alluded to, with an aperture of $\frac{1}{3}\frac{1}{2}$ of an inch, furnished with a scale for measuring the height of flame, and with a pressure-gauge, to which a graduated scale, with a vernier, was applied, and by which the pressure at the burner, necessary to keep up the combustion at the desired height of flame, could be measured to 100ths of an inch. The diameter of the pressure-gauge was half-an-inch, which, though it gave a considerable curve in the fluid, yet afforded more accurate results than when one with a smaller diameter was used. Indeed, I had recourse to various contrivances, such as floats in the water, with indices attached to them, and made to move on the scale; but I found, after numerous trials, that the simple wide gauge was by far the best, provided that care was taken to mark the height of the fluid from the same part of the curve. I always marked it from the bottom; and for this purpose had brass plates passing round the tube, and movable, so that they could be brought to the curve in both limbs.

In the following set of experiments, the gases were prepared from a variety of coals by means of the experimental apparatus. They were always consumed with a five-inch flame. The illuminating power was tried by the chlorine test. The specific gravity was taken in the usual way, by filling a vessel of known capacity with the gas, and noting at the same time the state of the thermometer and barometer. Not less than two trials were

made with each coal, and the experiments with each gas were frequently repeated; and when it was necessary, other gases were made, and the trials again repeated, so as to secure accuracy. The consumption of the gas was ascertained in the usual way, by an accurate experimental metre; the trials with the specific gravity, the pressure, and chlorine, being frequently repeated. Instead of giving the names of the coals, I designate them by letters.

Gases.	Illuminating power by chlorine.	Pressure at burner in 100ths of inch.	Square roots of pressures.	Durability by metre, 1 foot min.	Durability calculated by square root of pressure.	Difference between experimental and calculated durability.
					′ ″	′ ″
Standard.	24	42	6480	58	. . .	. . .
A.	8	122	11045	50	49·49	0·2
Aa.	11·5	80	8944	59·20	61·36	2·16
B.	13	76	8717	63 40	63·12	0 28
Bb.	15	64	8000	69·6	68·48	0·17
C.	15	72	8485	65·50	64·54	0 56
Cc.	15	63	7937	69 24	68·40	1·4
D.	15	60	7745	72	71	1·0
Dd.	17	56	7489	72 20	71·15	1·5
E.	23	40	6324	88·53	87	1·53
Ee.	24	38	6164	90·50	90·48	0·2
F.	19	50	7071	77·30	77·48	0·48
G.	22	46	6782	81·40	81	0·40
H.	12	79	8888	62·30	61·58	0·32
I.	22·75	38	6164	90·50	89·18	1·32
K.	12	72	8485	65	64·54	0·6
Average of the errors between the experimental and the calculated durability of the 16 trials, ...						′ ″ 0 42

From the foregoing table, it is evident, I think, that the mode of finding the consumption by the pressure is sufficiently accurate for all practical purposes. I mean, of course, merely with the view of finding the durability of gases, as I do not propose it as a method for superseding the use of metres, to ascertain the quantity of gas consumed by different individuals. I must mention, however, that in one or two instances, the observed pressure did not give the consumption, as indicated by the metre: whether this was owing to a peculiarity in the gas, or to inaccuracy in noting the results, I do not know. At the time that the experiments were performed, the results were merely marked down, and the calculations were made afterwards; and after discovering the want of correspondence, I had not then an opportunity of repeating the trials with the same coal, which was very remarkable for affording a gas of very high illuminating power. This was the more to be regretted, as the gas being at one extremity as to quality, made it appear, that there was some deviation from the rule I have laid down.*

* Since writing the above, I have fortunately had an opportunity of procuring the coal alluded to, and of preparing gas from it. All the trials were repeated with

From the foregoing experiments, it is evident that the durability of a gas can be easily ascertained, by using a burner with an aperture of a certain diameter, having a scale for measuring the height of flame, and a gauge for observing the pressure, at which the gas is burning, at that height of flame; of course taking care to make the measurement with accuracy. The consumption of any gas by this burner, with the height of flame fixed on, is first to be determined by metre, numerous trials being made; while, at the same time, at each trial, the pressure is also noted. By this means, and taking the average of all the consumptions and pressures, a standard is obtained. Suppose that with a flame of 5 inches, and a pressure of $\frac{7}{10}\frac{5}{0}$ths at the burner, the consumption of a gas is, by metre, found to be one foot in 65 minutes; and that another gas requires, with the same burner and height of flame, a pressure of $\frac{9}{10}\frac{4}{0}$ths; the square roots of these pressures are 8560254 and 9695359; then, as the latter is to the former so is 65, the time for the consumption of the latter, to 57·21. which is the time for the consumption of the former. Now $8560254 \times 65 = 5564165$; accordingly, this number divided by the square roots of the pressures necessary for the consumption of other gases, will give the times for the consumption of these gases, when consumed with the same burner, and with the same height of flame.

The jets now in general use, vary from the 28th of an inch, as recommended by Christison and Turner, to the 45th of an inch. Most of the trials which I have now recorded, were made with a jet of the 33d of an inch; not because I prefer it, but because I had begun my investigations with it, without being aware of the practical applications to which the results might lead; and having once begun with it, I thought it better to complete the experiments with it.

Since these experiments were finished, I have performed others, to enable me to find the best jet for the purpose now recommended. I had accordingly jets made with accuracy, the apertures in which were the 25th, 30th, 35th, 40th, 45th, and 50th of an inch; with all of which numerous trials were performed, to ascertain the consumption and pressure. I soon, however, rejected the first two, because they gave an unsteady flame; while the pressure-column in the gauge was not of any great length. With the remainder, the flame was more steady, and more easily measured, while the pressure column was of sufficient length to be easily marked. I soon, however, also, rejected the burner, No. 50, because unless the pressure on the street-pipes is great, it does

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great care, and were found to give results corresponding with those in the above table, so that there must have been an error in noting the results of the first trials. In the subsequent trials, repeated again and again, the consumption by metre and calculated by pressure differed only in 40 seconds.

not give a flame of sufficient height; indeed the same is sometimes the case with jet 45. For these reasons, I now prefer the jet 40, because, while it gives a very steady flame at 5 inches, the water-column in the gauge is much longer than when a jet 33 or 35 is used; and thus, any slight inaccuracy, in noting the pressure, leads to a smaller error in the results, than when the same inaccuracy is committed, in noting the pressure when the water column is not so long.

The following is the result of trials made with the different jets I have mentioned:—

Trials with Flame.

4 Inches.				5 Inches.			
Jets.	Pressure in 100ths of inch.	1 foot burned minutes.		Jets.	Pressure in 100ths of inch.	1 foot burned minutes.	
		′	″			′	″
25	15	75	35	30	50	65	25
30	30	75	30	33	68	64	25
33	44	75	41	35	110	65	0
40	90	72	55	40	120	63	40
45	110	72	30	45	155	64	40
50	196	75	0				

On viewing the results above given, it will be observed, that the times for the consumption of 1 foot are very nearly the same. Had the difference followed any regular gradation, then we might have supposed that it was occasioned by the difference in the size of the aperture in the jet; but as it does not do so, we may, I think, safely conclude, that, with jets of different apertures, and with flames of the same height, the quantity of the same gas consumed in the same way is the same; or that the times for equal consumptions are the same. That this is really the case is still farther proved by taking a small jet of gas, of given height of flame, and marking the consumption by metre; then removing the jet from the socket, which is left open, and consuming the gas from it; the quantity in the same time, will be found to be the same. Or, burn the gas from the latter, with a flame of such a height as can be measured with any degree of accuracy: then introduce a jet, and burn the gas with the same height of flame; the quantities consumed are the same, or as nearly so as can be expected from trials of the kind, where it is difficult to measure accurately the length of flame. Hence, most probably, the cause of the difference of time in the table given; that difference having been occasioned by the flame in some of the trials having been a very little too high or too low, in the cases where the difference is greatest. Even that difference, especially in the last table, the experiments of which were repeated again and again, with slightly varying results, is only 1′ 20″. This shews the necessity of repeated trials, altering the flame, and again bringing it to the fixed height, and each time marking the con-

sumption and the pressure, so that, by taking the average of many trials, an accurate result may be obtained. Having fixed on the jet 40, bushed with platinum, and furnished with the scale for the flame, and with the pressure-gauge, I found, by numerous trials, that the time for the consumption of 1 foot of a gas, was 64′ 41″, the flame being 5 inches. The pressure at the burner-gauge was $\frac{1}{1}\frac{1}{0}\frac{7}{0}$ths. The specific gravity of the gas was, by experiment in the usual way, found to be 602·6, at 60°, and barometer 30; of course one foot requiring 64′ 41″, then in 60′, there are consumed 0·927 of a foot. Thus, then, the consumptions being, in equal times, as the square roots of the pressures, and the times, for equal consumptions being inversely as the square roots, while the specific gravities are also inversely as the square roots of the pressures, the following table will give the consumption of gases in 60 minutes, the time for the consumption of a foot; and the specific gravity, at 60°, and barometer 30, calculated from the square roots of the pressures, the gases being consumed, with a flame of 5 inches from the jet 40; taking, as I have already stated, a gas of specific gravity 602·6, burning under a pressure of $\frac{1}{1}\frac{1}{0}\frac{7}{0}$ths, 1 foot in 64′ 41″; the square root of pressure 117 being 108166.

Should any other jet be found preferable, the quantity of gas consumed by it, with a flame of a fixed height, must be ascertained by repeated trials, with an accurate experimental metre; taking the pressure accurately each time. The average consumption and pressure being thus fixed on, the specific gravity is to be taken by experiment in the usual way; then the consumptions and specific gravity of other gases, with the same burner and height of flame, will be found, as already directed, with jet 40; and for which the table has been constructed.

TABLE, *shewing the Times for Equal Consumptions, the Consumptions in Equal Times, and the Specific Gravities of Gases, requiring the following Pressures to burn them, from Jet* 40, *with a* 5*-inch Flame.*

Pressure in 100ths of inch.	1 foot burns min.		100ths of foot in 60 mins.	Specific Gravities, Air=1000.	Pressure.	1 foot burns min.		100ths of foot in 60 mins.	Specific Gravities, Air=1000.
	′	″				′	″		
60	90	18	66·6	841·4	75	80	48	74 1	752·6
61	89	36	66·9	834·5	76	80	16	74·5	747·6
62	88	48	67·5	827·7	77	79	45	75·1	742·8
63	88	10	68·0	821·2	78	79	14	75·7	738·3
64	87	28	68·5	814·7	79	78	44	76·3	733 3
65	86	48	69·1	808·4	80	78	12	76·7	728 7
66	86	8	69·6	802·3	81	77	42	77 2	724·3
67	85	30	70·1	796·3	82	77	12	77·7	719 8
68	84	48	70·6	790·4	83	76	48	78·1	715·4
69	84	15	71·0	784 6	84	76	12	78·7	711·1
70	83	36	71·7	779·0	85	75	54	79·1	706·9
71	83	0	72·2	773·5	86	75	24	79·5	702·8
72	82	30	72·6	768·1	87	75	0	80·0	698·8
73	81	54	73·2	762·8	88	74	36	80·4	694·0
74	81	21	73·7	757·8	89	74	6	80·9	690·9

TABLE, *shewing the Times for Equal Consumptions, &c.*—Continued.

Pressure in 100ths of inch.	1 foot burns min.		100ths of foot in 60 mins.	Specific Gravities, Air=1000.	Pressure in 100ths of inch.	1 foot burns min.		100ths of foot in 60 mins.	Specific Gravities, Air=1000.
	′	″				′	″		
90	73	45	81·4	687·0	146	57	54	103·7	539·4
91	73	18	81·7	683·3	147	57	42	104·0	537·6
92	72	57	82·1	679·5	148	57	30	104·3	535·8
93	72	34	82·5	675 8	149	57	18	104·6	534·0
94	72	6	83·1	672·3	150	57	6	104·9	532·2
95	71	48	83·5	668·7	151	56	54	105·4	530·4
96	71	24	83·9	665·2	152	56	45	105·8	528·7
97	71	00	84·1	661·8	153	56	33	106·1	527·0
98	70	36	84·9	658·4	154	56	19	106·4	525·3
99	70	18	85·3	655·1	155	56	12	106·8	525·6
100	69	58	85·7	651·8	156	56	0	107·1	521·9
101	69	36	86·2	648·6	157	55	48	107·4	520·2
102	69	12	86·7	645·4	158	55	39	108·0	518·5
103	68	54	87·1	642·2	159	55	30	108·4	516·9
104	68	36	87·5	639·1	160	55	19	108·8	515·3
105	68	15	87·9	636·1	161	55	9	109·7	513·7
106	67	58	88·2	633·1	162	54	59	109·1	512·1
107	67	36	88·6	630 1	163	54	48	109·4	510·5
108	67	18	89·1	627·2	164	54	38	109·7	508·9
109	67	0	89·5	624·4	165	54	29	110·1	507·4
110	66	42	89·9	621·5	166	54	19	110·4	505·9
111	66	24	90·3	618·6	167	54	9	110·8	504·4
112	66	6	90·7	615·9	168	53	59	111·1	502 9
113	65	48	91·0	613·2	169	53	50	111·5	501·4
114	65	30	91·4	610·5	170	53	41	111·8	499·9
115	65	15	91·9	607·8	171	53	31	112·0	498·4
116	64	58	92·3	605·2	172	53	21	112·5	497·0
117	64	41	92·7	602·6	173	53	12	112·7	495·6
118	64	24	93·1	600·0	174	53	3	112·9	494·2
119	64	9	93·5	597·5	175	52	54	113·3	492·8
120	63	48	93·9	595·0	176	52	45	113·6	491·4
121	63	36	94·3	592·5	177	52	36	114 0	490·0
122	63	21	94·7	590·1	178	52	27	114·3	488·6
123	63	6	95·1	587·7	179	52	18	114·7	487·2
124	62	50	95·4	585·3	180	52	9	115·0	485·8
125	62	35	95·8	582·9	181	52	0	115·3	484·5
126	62	18	96·2	580·6	182	51	52	115·5	483·2
127	62	6	96·6	578·3	183	51	43	115·8	481·9
128	61	51	97·0	576·1	184	51	34	116·2	480·5
129	61	36	97·4	573·9	185	51	27	116·6	479·2
130	61	21	97·8	571 7	186	51	19	117·0	477·9
131	61	8	98·2	569·5	187	51	12	117·3	476·6
132	60	54	98·6	567·3	188	51	2	117·6	475·3
133	60	36	99·0	565 2	189	50	54	117·9	474·1
134	60	27	99·3	563·1	190	50	46	118·2	472·9
135	60	12	99·6	561·0	191	50	37	118·5	471·6
136	60	0	100·0	558·9	192	50	30	118·8	470·4
137	59	45	100·3	556 8	193	50	22	119·0	469·2
138	59	33	100·7	554·8	194	50	14	119·4	468·0
139	59	21	101·1	552·8	195	50	6	119·7	466·8
140	59	8	101·5	550·8	196	49	59	120·0	465·6
141	58	54	101·9	549·0	197	49	51	120·3	464·4
142	58	42	102 3	547·0	198	49	44	120·7	463·2
143	58	30	102·6	545·1	199	49	36	120·9	462·0
144	58	18	102·0	543·2	200	49	29	121·1	460·8
145	58	6	103·3	541·3					

Before concluding I wish to advert briefly to a mode of fixing the illuminating power, which, so far as I am aware, has not been publicly noticed in any of the papers lately printed. Dr. Lyon Playfair, who described it to Mr. King of the Gas Works, Liverpool, from whom I first got the account of it, ascribes it to Professor Bunsen of Marburg; and, accordingly, as I understand, he has the merit of proposing it. It consists of a sheet of paper, besmeared with spermaceti, excepting at a small part at the centre, by which the besmeared portion becomes more pervious than the other to light; and consequently a light placed behind it, causes a dark spot on that part not covered. When another light is placed before the paper, the spot is distinctly visible, if that light be placed at such a distance as to cause the reflexion from the paper to be either of greater or of less intensity than that transmitted. When however, it is so situated that the transmission from behind, and the reflexion from before, are of the same intensity, then the spot is invisible; the paper appears as if uniform throughout. Now, with a light of uniform intensity placed behind, the transmission will always be the same. If another light before the paper requires to be at the distance of 5 inches, and another at 10 inches, to cause, one after the other, the spot to disappear, then, according to the usual law, they are giving light as 25 and 100, *i. e.*, 1 to 4. After a little practice I have found this photometric process extremely delicate. It has many advantages over the shadow test: for instance, the difference in the color of the shadow is avoided; besides, the trials can be conducted without darkening the room, unless there are cross lights or sunshine directly into the apartment.

With regard to the light to be placed at the back of the screen, the only uniform source with which I am acquainted is a wax or spermaceti candle, of the same diameter, and with the same thickness of wick. With regard to the modes of preparing the paper, I at first used spermaceti melted, as recommended by Mr. King, and applied it to bibulous paper in various ways; but I never succeeded in getting it uniformly spread over the surface,—it was generally thicker at one part than at another, which gave rise to a difficulty in fixing the distance at which the light should be placed. After trying different methods, I have, however, succeeded in getting the paper properly prepared. The process I now follow, is to dissolve spermaceti in distilled oil of naphtha, till it gives a mixture, which at natural temperatures is solid; but is liquefied by the application of *a very slight heat*, such as by holding the vessel in the hand for some time. When fluid, it is to be applied by a hair-pencil to the paper, leaving a part of about the size of a half-crown piece at the centre uncovered. After this the paper is held *horizontally* over a lamp, *and very cautiously heated*, by which all inequalities disappear. I prefer the fine cream-colored paper now much used as letter paper.

A screen fitted up in this way, stretched on a frame, with a holder for the light at the back, and with another holder in front for the other light, is all that is required: of course, if gases are to be tried, the holder in front must be furnished with a jet of the diameter previously fixed on, and with a flexible tube to be connected with the gas-pipe. This holder can be made to move backwards and forwards on a scale, graduated to inches, with their corresponding squares; or to lights of candles, as may be thought proper. To make the apparatus more complete, the gas-jet can be furnished with the pressure-gauge, which I have recommended for ascertaining the durability; and thus, by the two together, the *value* of gases may be quickly ascertained.

This mode of trying the illuminating power will be found very useful; not that I prefer it to the chlorine test, for by the latter, all gases can be compared with a standard of unity, the illuminating power being just as the condensation; but because the former is easily managed, especially by those not practised to work with water-troughs. Could a truly uniform source of light be procured, and, by general consent, be fixed on, as that for the back of the screen, then the light from gases, or indeed from other sources, could be compared with it; but as yet, we are not so far as I am aware, in possession of such a light.

With the use of the screen now described, I was anxious to repeat the trials made, with the view of ascertaining the light for equal consumptions of gases by different burners; an account of which was published in the Transactions of the Society for 1842, because I have again and again heard the accuracy of these results called in question. In conducting the trials, I had, as before, recourse to an experimental metre, to ascertain the consumption, and made use of a gas-jet flame, always of the same height, and always at the same distance from the back of the screen. Each series of trials being conducted in one day, the gas was, of course, of the same quality for each day, by which a uniform transmission of light from behind was obtained.

The following are the average results:—

Burners.	Consumption in 60 minutes.	Light by flame.	Light for equal consumptions.
Jet—flame 5 inches,	1 foot.	1·00	1·00
Small Fishtail,	1·98	2·89	1·45
Large Fishtail,	2·60	4·00	1·53
Small Batwing,	3·00	4·40	1·46
Large Batwing,	4·60	8·40	1·87
Argand, 40 holes,	4·50	7·84	1·74

In the paper published in 1842, it was stated that the most profitable way of consuming gas is by the Argand, properly constructed; in other words, that for equal consumptions, the greatest amount of light is given by the Argand; next by the batwing;

then by the fishtail; and, lastly, by the jet, which is the least economical; and, consequently, lighting by gas is comparatively, for equal amount of light, by far most expensive to those having recourse to this mode of burning it, such as to those requiring small quantities. The light, as then stated, was in the ratio of 100, 140, 160, 180. In the trials now recorded, the results do not all correspond with these. With the small fishtail and the Argand they do so very nearly; the burners used having been the same as formerly. The others, such as the large fishtail, not formerly tried, is more economical than the small fishtail; the small batwing, also not formerly tried, is not more economical than the small fishtail, and much less so than the large fishtail. The large batwing, the largest I have ever seen, is equally economical with the Argand: I found it very liable to smoke. The general results of these trials may, however, be said to correspond with those previously given, proving the accuracy of my former statement, that the jet is the worst kind of burner, giving least light for the same consumption; next come the fishtails, generally speaking; then the batwings of medium size; and, lastly, the Argand.

Art. XII.—*Notes on some Chenopodiacea, growing spontaneously, about the City of New York;* by John Carey.

My attention having been directed, during the past autumn, to the Chenopodiaceous plants of this vicinity, I was surprised to find, growing in considerable abundance about the waste lots in the first and second avenues of the city of New York, (near 14th street), a plant, which, though differing in some slight particulars, I cannot doubt, is the *Roubieva multifida*, Moq.-Tand. (Chenopodium multifidum, *Linn.*, Atriplex multifida, *Crantz*, C. Payco, *Molin. Chil.*, Ambrina pinnatisecta, *Spach*, *Veg. Phan.*) This synonymy I derive from the elaborate *Chenopodearum Monographica Enumeratio*, of Moquin-Tandon, where I find the species referred to South America, and the Cape of Good Hope. I am not aware that it has hitherto been noticed in any of our Floras, as occurring in the United States, nor have I ever seen a specimen; with the exception of a small piece in the herbarium of my friend Professor Torrey, which he appears to have received, without a name, from "Virginia, Dr. Aikin, 1813." Feeling some interest in this discovery, I have been led to examine the characters of the genus *Roubieva*, founded on this single species, as contrasted with the subsequently published *Ambrina* of Spach, who proposed to comprehend the *Chenopodium multifidum*, L., within its limits; being ignorant, no doubt, of the prior genus

established by Moquin-Tandon. I regret that I have not the means of referring to the original paper of Spach for the character of the genus *Ambrina*, which, as given by Moquin-Tandon, differs chiefly from that of *Roubieva* in the 2 (not 3) styles, and in the comparative length of the embryo with respect to the albumen, it being "$\frac{2}{3}$ to $\frac{3}{4}$ annular" in *Ambrina*, and completely so in *Roubieva*. The inflorescence of the former is described as "spicate-paniculate," and of the latter, very correctly, as having "axillary, solitary or glomerulate flowers, the glomerules being sometimes almost verticillate."* Upon examination of the three species of *Ambrina*, growing abundantly in the same neighborhood with *Roubieva*, I do indeed find that *A. Botrys*, Moq.-Tand., (referred by Spach to his genus *Botrydium*,) has commonly but two styles—though I have detected three, occasionally: but *A. ambrosioides*, Spach, and *A. anthelmintica*, Spach, have constantly, or with very rare exceptions, three styles; which as to the latter species, is noticed by Moquin-Tandon himself. With respect to the inflorescence, I find that three species are described by this author, under *Ambrina*, as having few-flowered, axillary glomerules, *not spicate*, viz. *A. carinata*, and *A. Pumilio*, from New Holland, and *A. tenuis*, from Chili. These exceptions being admitted, the genus *Ambrina*, including (as arranged by Moq.-Tand., though not by Spach) species with horizontal and vertical fruit, would seem to rest mainly upon the *incompletely* annular embryo; for, I do not find the (rather dilated) filaments in *Roubieva* "somewhat inserted into the perigonium," but as in *Ambrina;*

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* As the above cited valuable work is known to very few American botanists, I extract, for their information, the full generic characters, as follows:

Roubieva. *Moq. Ann. Sc. nat. 2. ser.* 1, *p.* 292, *t.* x, *f. B.*—Flores hermaphroditi, ebracteati. Perigonium profundè urceolatum, oblongum, quinquefidum, nunquam appendiculatum; laciniis demum coalitis, subpentagonam rugosamque capsulam effornantibus. Stamina 5, imo perigonio inserta. Stigmata 3, longa, subulata. Fructus (utriculus) compressus, perigonio capsulari involutus (et dimidio brevior); pericarpio membranaceo, punctis resinosis consperso. Semen verticale, lenticulare; integumento exteriore crustaceo. Albumen copiosum, farinaceum, candidissimum. Embryo annularis; radicula infera.—Herba, prostrata, diffusa, pubescens. Folia alterna, pinnato-multifida; laciniis dentatis. Flores solitarii aut glomerulati (glomerulis interdùm feré verticillatis), axillares. Stamina quandoque abortiva, unde flores feminei. * * Facies Senebieræ pinnatifidæ. Planta odorem ambrosiacum spirat. Radix angustè fusiformis, longa. Capsula reticulata. —*Moq.-Tand. l. c.* p. 42.

Ambrina. *Spach, Veg. Phan.* 5. *p.* 297 *et* 299, char. reform.—Flores hermaphroditi, ebracteati. Perigonium quinquefidum vel quinquephyllum (interdum 3-4 fidum), nunquam appendiculatum. Stamina 5, rarissimè pauciora, receptaculo inserta. Styli 2, infernè coaliti. Fructus (utriculus) depressus aut compressus, perigonio clauso involutus, interdum supra nudus foliolis imperfectè clausis; pericarpio tenui, distincto. Semen horizontale aut verticale, lenticulare; integumento exteriore crustaceo. Albumen farinaceum. Embryo $\frac{2}{3}$ aut $\frac{3}{4}$ annularis.—Herbæ pubescentes, aut subpubescentes, glandulosæ et graveolentes (haùd farinosæ). Folia alterna, petiolata, dentata, sinuata aut pinnatifida. Flores minutissimi, spicatim paniculati.—Genus inter Chenopodium et Blitum intermedium, Roubievæ affine. Semina nunc horizontalia ut in Chenopodio, nunc verticalia ut in Blito; sed embryo totum non perficit annulum et vix albuminis $\frac{2}{3}$ aut $\frac{3}{4}$ includit. Pubescentia glandulosa et odor aromaticus valdé naturalem constituunt seriem.—*Moq.-Tand.*, l. c. p. 36.

nor do I remark the "deeply urceolate" perigonium. If the above three species of *Ambrina*, with few axillary flowers, and of which Moquin-Tandon had not sufficient knowledge, should prove rather to belong to *Roubieva* by having a *completely* annular embryo, the genus *Ambrina* may perhaps be considered as confirmed; but, otherwise, though with due deference to the great authority of Moquin-Tandon who has adopted it, I cannot regard it as other than a (not very marked) section of *Roubieva*—since the admitted species of *Ambrina* differ in the *degree* in which the embryo surrounds the albumen, and the generic character is drawn accordingly.

Elliott remarks of *A. anthelmintica*, that "it is probably our only indigenous species" (of Chenopodium), adding: "the specimens of this plant which I have received from the Eastern States differ from ours by leaves less rugose, dentate not sinuate, and flowers in detached clusters (glomerules), not in paniculate spikes as with us." This form I also find here; and have thought that it might possibly be a hybrid, as it grows intermingled with the Southern (typical) state of *A. anthelmintica*, and *A. ambrosioides*, and has, in fact, a very intermediate appearance, between them.

Chenopodium rhombifolium, Muhl., is considered by Moquin-Tandon as a variety (*β. rhombifolium*) of *C. urbicum*, *Linn.*; but, though what I suppose to be the plant of Muhlenberg, and of Darlington, Fl. Cest., grows very abundantly in the upper part of the city of New York, and elsewhere in the United States, I never saw a specimen actually agreeing with the European type of *C. urbicum*, from which I believe our plant to be distinct.*

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* This species attracted the particular notice of that accomplished naturalist, Dr. Wm. A Bromfield, of the Isle of Wight, who kindly directed my attention to an immature specimen which he gathered in the suburbs of Philadelphia. This intelligent traveller also informed me that he had observed *Chenopodium glaucum*, a species which has not passed under my notice, growing in the same city. In his very interesting "Notes and Observations on the Botany, Weather, &c., of the United States of America," Dr. Bromfield has the following remarks on these and other Chenopodiaceous plants which he saw in the neighborhood of this city, and Philadelphia. "I found *Chenopodium glaucum* growing in the dockyard (at Philadelphia) on moist spots near the water, and on a large piece of waste ground at the end of Fourth street; this is, I believe, a rare species in America, and probably of comparatively recent introduction, as the botanists of that country, and even of Philadelphia, seem very little or not at all acquainted with it. Four other species of the same genus, *C. album*, *ambrosioides*, *anthelminticum*, and *botryoides* (C. Botrys, L.? C. botryodes, Sm., being a var. (β. crassifolium) of Blitum polymorphum, C. A. Mey. fide Moq.-Tand.) are found in waste places in and around the city, besides a fifth, allied to our *C. urbicum*, but certainly distinct from that and *C. rubrum*, for which last, I believe, it passes here, and to which I am desirous of drawing the attention of American botanists, as being probably a non-descript. The plant has much resemblance to *C. anthelminticum* in its inflorescence, but is quite destitute of the strong smell of that species, and it resembles *C. urbicum* in the slender, erect, somewhat branched, nearly naked racemes, that bear a few small leaves amongst the lower clusters only. It is more branched and spreading than either of the two, or, indeed, than in any of the upright forms of the European *C. rubrum* that have come under my notice, which it was pronounced to be (I am sure erroneously) by some botanists of the town, to whom I showed it at a meeting of the Horticultural Society of Philadelphia. The only speci-

The leaves vary greatly in size, and *when young* are white and mealy beneath, in which state it has a resemblance to *C. glaucum*. By American botanists it has been very commonly referred to *C. rubrum*, L. (*Blitum polymorphum*, C. A. Mey.) a very different plant, with vertical fruit, and of which I have seen no American specimen. The "*C. urbicum*, L. ?" of Fl. Bor.-Am., under which is cited *C. intermedium*, Mert. and Koch, is *C. hybridum*, L., as I ascertain from an authentic specimen in Dr. Torrey's Herbarium, labelled "*C. intermedium, Fl. Bor.-Am.*" Indeed, Hooker remarks that the plant "exactly accords with the C, hybridum" of the English Botany; and that it was what he had "received from the American botanists as C. hybridum: but that species has a more panicled inflorescence with divaricating branches." In this particular the plant probably varies with growth as it certainly does in some other characters. I have two varieties from my friend, Mr. S. T. Olney, of Rhode Island; one with a green stem, naked panicles, and leaves cordate at the base; the other with a red stem, somewhat leafy panicles, and leaves acute at the base. *Chenopodium intermedium*, Mert. and Koch, is adduced by Moq.-Tand. as a variety (γ. intermedium) under *C. urbicum*, and the short character he gives would not seem applicable to C. hybridum. I have not, however, the means of determining this discrepancy in the synonymy. I do not remember to have noticed *C. hybridum* in the suburbs of New York, though it doubtless occurs there, as I have observed it growing at Hoboken. Indeed, it is probable that these homely weeds are often overlooked or mistaken, where they are not uncommon. *C. murale*, L., hitherto considered rare, I find growing about the waste lots, in this city, and at Hoboken; and have received it from Mr. Olney, who collects it about Providence. I also find it in the Herbarium of Dr. Torrey, from Prof. Short of Kentucky, together with *C. hybridum*, the latter gathered "amongst the almost inaccessible cliffs of the Kentucky river." It is certainly difficult to determine which of these species should be considered as strictly native plants, but, although the whole are arbitrarily excluded by Nuttall, there seems no good reason why some of them, at least, should be less so than the common species of *Ambrina*, which, he asserts, "only are indigenous."

New York, November 30, 1848.

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mens I collected for examination were picked at the entrance to the wharves and woodyards of Kensington, where it occurs frequently. * * * I have not seen it in fruit, the plant having quite disappeared when I sought it again in the November following. * * *Chenopodium murale* grew near our starting point at Camden (New Jersey); an apparently uncommon plant in America, and perhaps introduced. I remarked it, however, in some plenty under walls at the Castle Garden in New York, and very commonly about Norfolk, Virginia, corresponding exactly with specimens from the Isle of Wight."—*Hook. Lond. Journ. Bot., April*, 1848, p. 211.

APPENDIX.

As my communication of November 30th was too late for the last number, I am now enabled to add a further note, derived from "*The Botany of Capt. Beechey's Voyage*," to which I have only just procured access. A Californian plant, considered by the authors as a probable variety of *Chenopodium anthelminticum*, L., is there referred to *Roubieva*, Moq.-Tand., and the following observation appended to the description.—"The genus Roubieva of Moquin-Tandon, distinguished from Chenopodium by its vertical seed, and from Agathophytum by the keeled segments of its perianth, which form a pentagonal covering to the nut, was constituted for one or two South American species, but ought to include the present plant and a few others indicated by Spach under his Ambrina, which does not differ."—*Suppt. Bot., Beechey's Voy.*, 1841.

It would hence appear that my view of the identity of the genera *Roubieva* and *Ambrina* (the latter as constituted by Spach) has been anticipated by Hooker and Arnott, but, from their contrasting characters, as given above, these distinguished botanists did not seem to contemplate the admission of the species with horizontal seeds, constituting the genus *Botrydium* of Spach, but which is reduced by Moq.-Tand. to a section (*Botryoïs*) of the genus *Ambrina*.

J. C.

January 22d, 1849.

ART. XIII.—*Analysis of the Braunau Meteoric Iron;* by Dr. N. W. FISCHER.*

(Continued from vol. v, p. 342.)

IN the enquiry instituted by Prof. Duflos and myself, we made use of the filings which, as has been mentioned, I had been permitted to remove from the mass during my presence at Braunau, and we could thus only treat of the iron as a homogeneous body. Now however having, by the especial kindness of Dr. Rotter, been put into possession of a solid mass of more than 20 grammes in weight, my attention was primarily directed to ascertain of what heterogeneous substances this meteoric iron consists; and the results at which I have arrived are, that it contains three such bodies.

One of these is by far the most predominant, forming the general mass, and is a compound of iron, nickel and cobalt, with traces of other substances, as stated in the result to which our investigations led us.†

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* Translated by W. G. LETTSOM, Esq., of London, from Poggendorf's Annalen, vol. lxxii, p. 575, and communicated by the translator to this Journal.

† Several of the substances alluded to there, are probably attributable to the presence of the two other bodies

The second body occurring imbedded here and there in the general mass, and which is readily distinguishable therefrom by its color, fracture, brittleness and lustre, may be extracted without much difficulty by mechanical means.

The third, in fine, can be separated from the meteoric iron in the form of small plates or spangles, by allowing the action of chlorohydric acid to continue thereon as long as a solution goes on forming.*

I do not consider that there is ground for regarding the black powder, which is separated by the action of the acids, as also a peculiar and distinct body, inasmuch as it contains the several constituents of the general mass, which are thus separated owing to their insolubility in the acids employed.

Although my endeavors were directed towards ascertaining the ratio of the constituents of these two substances, that is to say, the bodies two and three, yet from the extremely minute quantity thereof at my disposal, I was forced to confine myself principally to their qualitative examination.

1. *The imbedded substance.*—Diluted chlorohydric acid which does not exert any action upon the principal mass for some time, disengages at once a considerable quantity of sulphuretted hydrogen when poured on to this body, dissolving it completely, with the exception of a minute residue in the form of a greyish black powder. The hydrogen given off by the general mass during its solution in chlorohydric acid has not, it must be observed, the slightest smell of sulphuretted hydrogen with it, unless some of these scales or spangles happen to be present. This powder when transferred to a strip of thin platina foil and exposed to a moderate heat takes fire, glimmering like tinder, a phenomenon which is repeated upon the foil attaining a red-heat. The powder which has now become of a brown color was fused with nitrate of soda on platina foil and exposed to a red-heat. On becoming cold the salt was of a yellow color, which color it retained when dissolved in water. This solution after being neutralized with nitric acid —for the double purpose of converting both the caustic soda and the nitrite of soda into a nitrate—produces in a solution of nitrate of silver a beautiful red precipitate, readily soluble both in nitric acid and in ammonia, from which solution it is a second time thrown down, of the same brilliant red color as before, by reciprocally rendering the solution neutral; that is to say, the nitric solution by ammonia, and the ammoniacal solution by nitric acid.†

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* Berzelius found a body of a similar nature in the meteoric iron of Bohumilitz, and which he termed scales, they were however white, more granular and heavier, and could therefore be separated by adulcoration from the carbonaceous powder disengaged at the same time with them from the mass, a proceeding that is only partially successful with the minute spangles in question.—(See Pogg. Annal, vol. xxvii, p. 122.)

† The reaction given here for chromic acid appears to me to be at once very characteristic and sure, added to which, it is remarkably simple.

The chlorohydric solution contains iron and a small quantity of nickel.

The ratio of the portion soluble in chlorohydric acid to the insoluble is in 100=97 : 3.

(I had not above 0·073 grm. at my disposal for this examination, of which 0·002 remained undissolved.)

The constituents of this substance are consequently

Iron,
Sulphur,
Nickel.
Chromium.
Carbon.
} in 100=78·9 simple sulphuret of iron.

From the 0·073 grm. employed, the amount of peroxyd of iron thrown down from the chlorohydric solution was 0·083, consequently equal to 0·057 of metallic iron. This, in order to form simple-sulphuret of iron would require 0·033 sulphur; the sulphuret of iron would therefore alone amount to 0·090, that is to say, more than the weight of the body employed. A minute portion of the iron must therefore be combined with nickel, carbon and chrome in the body under examination. I was not able to detect the presence of phosphorus therein.

2. *The metallic scales, or spangles.*—Easy a matter as it is to obtain the first substance in a state of purity, namely, by separating it from the principal mass by mechanical means, it is one of equal difficulty to obtain this body free from those substances which, like these scales themselves, are left as a residue after the action of chlorohydric acid upon the mass, namely, carbon, silica, &c. The quantity of this substance obtained is moreover extremely limited, scarcely indeed exceeding one per cent. of the mass even when taking into account the powder with which it is separated in common.

Chlorohydric acid exerts no action whatever upon this substance, and nitric acid attacks it but very slightly; in nitro-muriatic acid however, it is readily soluble by the application of heat, leaving merely a slight residue of silica.

This solution when completely evaporated to dryness, leaves a residue, on the surface of which there is a formation of shining reddish-yellow scales easily detached from the glass; the inferior portion consists of a yellowish white mass adhering thereto. Both are completely insoluble in water, yet the white mass, provided it has been dried by a gentle heat, passes with the water through the filter; when a strong heat on the other hand has been employed to dry it, the white mass remains upon the filter, as do also the yellow scales. Both portions of the residue are readily soluble with a yellow color in chlorohydric acid, their behavior being that of basic phosphate of the peroxyd of iron.

Heated upon platinum foil this substance, like the former one, takes fire at a moderate heat, glimmering like sugar, losing thereby its metallic lustre and being converted to a brown powder from which both chlorohydric and nitric acids dissolve out a considerable portion.

The constituent parts of this substance are:

Iron, phosphorus, nickel, carbon and silica. Berzelius in the scales from the Bohumilitz iron found the *same constituents* in the following proportions: but whether those proportions obtain in the scales now under examination, I could not from the small quantity at my disposal, (=0·047 gramme,) ascertain.*

Iron	65·977
Phosphorus	14·023
Nickel	15·008
Carbon	1·422
Silica.†	2·007

The iron was the only element I endeavored to determine approximately, and in the present case it amounted to 51 per cent. or thereabouts.

These two substances, both the imbedded one and the scales, form. disregarding the other constituents, a remarkable contrast. The former consisting principally of sulphuret of iron, and the latter of phosphuret of iron. Another peculiarity is that the former substance occurs only here and there, and comparatively speaking, in considerable masses; while the second substance on the contrary, is generally diffused throughout the mass and in such very minute spangles:—this difference in the disposition of the two bodies being probably to be accounted for by their different fusibility and setting-point upon cooling.

The phosphuret of iron separates at a temperature at which the sulphuret of iron still remains in fusion, thus allowing the latter to unite into larger masses.

That the scales are very generally diffused through the mass is proved by the action of chlorohydric acid, for even in a very little while they are thus rendered visible, especially upon shaking the fluid, which causes them to float about therein. This conduct tends at the same time to establish their minuteness and levity, inasmuch as in spite of their general diffusion they do not amount to one per cent. of the mass, and this even when taking into account the carbonaceous powder separated simultaneously with them.

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* Berzelius had it in his power to employ about 60 grammes of the meteoric iron to obtain the scales, and the quantity he thus procured amounted to about 0·777 gramme. All that I had to work upon was about 5 grammes, inasmuch as I had lost a considerable portion of the iron I had through an accident, which I will subjoin in a note at the close of this Paper as a caution to other experimenters.

† See Berzelius in Poggendorf's Annal., vol. xxvii, p. 131.

In the Bohumilitz meteoric iron, the scales with the powder amounted to 2·26 per cent., alone 1·3 per cent.

Additional Note.—In order to obtain a sufficient quantity of these scales, I had put my entire stock of iron (previously broken up into fragments) into a small bottle—one of Faraday's washing-bottles—and had poured chlorohydric acid upon it, and had closed the bottle by means of a small cork into which a long narrow tube bent at an obtuse angle was adapted. After allowing the action of the acid to continue 16 hours, I approached the small flame of a spirit-lamp with a single wick, to the elbow of the tube, in order to ascertain whether the hydrogen given off contained arsenic, when after a short interval a violent explosion took place shattering the bottle to pieces.

That under these circumstances, in spite of the long continued action of the acid, the bottle should be still filled with an explosive mixture of gases, is noways surprising, it is however remarkable, that the gas thus formed should explode so very speedily upon the tube being gently heated. The explosion is probably to be ascribed to the hydrogen, containing also sulphur or phosphorus, though perhaps only in minute traces. As the bottle was completely broken to pieces, I was enabled to find again only a few small portions of the meteoric mass operated upon, and these were employed to obtain the scales.

ART. XIV.—*On the Acid Springs and Gypsum Deposits of the Onondaga Salt Group;* by T. S. HUNT, of the Geol. Survey of Canada.

Read before the American Association for the Promotion of Science.

THAT portion of the upper Silurian system of New York, which has been designated by the geologists of that state, the Onondaga Salt Group, is characterized not only by the saline springs to which it owes its name, but also by numerous deposits of gypsum and springs which are sour to the taste and contain free sulphuric acid. The one at Byron, New York, has long been known, and several others have been observed more recently in the same geological district. The same region in Canada affords a remarkable spring of this kind, which, in the course of my official duties, I had occasion to examine in the month of October, 1847. It is situated in the township of Tuscarora, in the Indian Reserve, about twenty miles north of Port Dover, which is the nearest point on Lake Erie. The water contains a large amount of free sulphuric acid, about 4 parts in 1000, besides sulphates of the alkalies, lime, magnesia, aluminum and iron in small quantities. The proportion of these ingredients is however not constant, as is ev-

ident from an analysis made in April, 1846, by Prof. Croft of King's College, Toronto, which is confirmed by a partial examination by myself, of a specimen of water brought from the spring in June, 1845.

The specific gravity of the water was much lower, and the amount of foreign ingredients much less, than in that collected by myself, but the proportion of bases to the acid was much greater. The proportion of the lime to the acid I found to be about 1:15, and that of the magnesia 1:90, while Prof. Croft's determination gave about 1:6 and one to 1:15, respectively. That collected in 1845 is a nearly saturated solution of gypsum, while that of 1847 contains no more than about 7 parts in 10,000.

These facts indicate a rapid change in the constitution of the spring, and its situation shows it to be of comparatively recent origin; for although the powerful acid has destroyed all traces of vegetation for a distance of several yards around the source, the water issues from beneath the roots of an enormous pine-tree, whose half decayed stump still stands several feet in height, while the crumbling mould from its slow decay, forms the surface soil for some distance around. Without overlooking the antiseptic virtues of the mineral substances contained in this remarkable spring, this fact shows that its antiquity can scarcely be greater than a century, if indeed half that cycle may not extend beyond the time of its first development, while the rapid decrease in the quantity of the saline bases shows that its character remains constant scarcely for a twelve-month. It should have been observed that there are four or five basins within the distance of as many yards, and that they are situated on the summit of a low mound which rises with a gradual slope from the marshy plain.

The probable cause of these changes will be seen by adverting to the character of the gypsum deposits of this formation, which I regard as having an intimate connection with this class of springs. The investigations of Mr. Hall, in New York, and Mr. Murray, in Canada, unite in showing that the gypsum of these rocks always occurs in hillocks or dome-shaped masses, varying in size from one foot to 300 or 400 feet in diameter, and always near the surface of the formation. Sections of these masses show them resting upon undisturbed strata of limestone, while the superior strata are thrown up and rest upon the flanks of the intruded hillock, often very much broken, and, as Mr. Hall has remarked, in part consumed, so that one is at a loss to account for the disappearance of a large portion of the overlying strata. In one case observed by Mr. Murray, a slender cylinder of gypsum passes through several beds of the limestone, and at last terminates in a cone of the usual form, which is entirely superior to the limestone formation and surrounded by the tertiary clay of the region. The comparatively recent origin which this assigns to the gypsum

deposits, is confirmed by the common experience of the people of Western New York, where it is a well known fact that since the settlement of the country, walls have been disturbed and houses raised from their foundations by a gradual elevation of the surface, where subsequent examination has shown the presence of domes of gypsum.

On comparing these facts with those observed in connection with the acid spring, it appears probable that the origin of the gypsum is to be ascribed to the action of such mineral waters upon the calcareous strata. How far the pressure at a great depth may operate in preventing chemical changes, we may not know, but it is easy to see that once coming to a situation where it could act upon the limestone, it would evolve carbonic acid gas, and form a calcareous sulphate which from its sparing solubility would be at once deposited in a crystalline form, while the water would pass off saturated with the sulphate, and at the same time carrying with it the soluble sulphates of magnesia, alumina, and iron, which would be formed from the other bases, generally present in the limestones of this region. If the amount of acid were copious, or the supply of calcareous matter limited, the water might rise to the surface with free acid, as in the cases already noticed, and when the deposition of calcareous sulphate had extended so far as to protect the carbonate from farther action, the water would appear with a much smaller portion of bases than before, having only the sulphate of lime which it could dissolve from the sides of its channels.

If on the contrary, the acid were entirely neutralized, the spring would present at the surface the character of an ordinary bitter saline, containing calcareous and magnesian sulphates; two springs of this character are indeed found in the same formation not far from here. The ferruginous and argillaceous substance known as *gypsiferous marl*, which surrounds these deposits, seem to be due to the precipitation by the carbonate of lime of the iron and alumina, which have been previously taken up by the water yielding a mixture of these oxyds with carbonate and sulphate of lime. The fact that crystalline gypsum occupies nearly twice the space of an equivalent quantity of carbonate of lime, will at once explain the displacement of the superincumbent materials. The observation which is now required to confirm this theory, is to find the carbonic acid which should be evolved from the decomposition of the limestone, actually disengaged from one of these springs; the small quantity of gas which rises from the Tuscarora spring was found to be principally carburetted hydrogen, which is copiously evolved by the salines of this region, but it was collected at a time when from the minute portion of gypsum in the water, the action seems to have been at an end. I shall not attempt to speculate upon the probable source of the

sulphuric acid at present, but shall defer the consideration of the subject until the publication of my report on the mineral springs of Canada, which will be accompanied with the analyses of this water as collected in different years. Hoping that my observations may resolve a hitherto unexplained problem in the geology of this region, I beg leave to submit them to the notice of the Association.

ART. XV.—*On the Fundamental Principles of Mathematics*; by STEPHEN ALEXANDER, Professor of Mathematics and Astronomy in the College of New Jersey.

THE object of this dissertation is to present, to some extent at least, those ultimate principles and reasons, on which are founded the conclusions of mathematics; principles and reasons which lie beneath the artificial symbols which the science employs; i. e. —to borrow a most expressive and beautiful figure—an attempt will be made to seize upon and exhibit, in so far as may be, that "central thread of common sense, on which the pearls of analytical research are invariably strung."*

In pursuance of the object thus indicated, a definite arrangement will be made of the several topics to be specially considered, each under its own descriptive title; commencing with the following:

The Characteristics of Truth, especially Mathematical Truth.

(1.) *Truth*, which may be employed to designate the great object of all scientific research, is a term much too valuable to be misunderstood, but withal so general as not to admit of a ready definition. Yet, under its various aspects, truth will be found to present the characteristic feature of consistency with some great standard. Thus a careful consideration of its subjects of research will show that

That is *true* in *Mathematics*, which, under the existing system of things, is *supposable*. It is in no case requisite that the supposition should have been realized.

[No one, for instance, has ever seen a perfect circle; yet every one, who has carefully considered the matter, can clearly understand what a perfect circle ought to be, and will concede that its existence is entirely possible, perfectly *supposable*.†]

That is *true* in *Physics*, or (with some restrictions of application) in *Metaphysics*, which has been *permitted to exist*.

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* Sir J. F. W. Herschel—Cabinet Cyclopædia, Treatise on Astronomy, (10).

† Among the truths *supposable*, must even be classified those expressed by the aid of what are termed *imaginary quantities*.

[It *might be true*, in so far as we can discern, that heavy bodies should have been so constituted as in every case, to fall to the earth in an arc of a circle, or any other given curve. It *is a fact* that heavy bodies, falling freely, always fall to the earth in straight lines.

Glass might, perhaps, be so constituted under a new arrangement of things, that every known liquid would dissolve it; and this, without ceasing to be essentially what it now is. As things are now constituted, scarcely one or two of the known liquids will touch it.

In *Metaphysics*, moreover, one of the primary inquiries is not, whether it be *supposable* that man should be endowed with such faculties as reason, memory, &c.; but whether he *in fact* possesses them.]

Not to multiply examples, but recapitulating the characteristics already mentioned, we observe, that

That is *true* in *Mathematics*, which, under the existing system of things, is *supposable*—*That* is *true* in *Physics* and (with some restrictions) in *Metaphysics*, which has been *permitted to exist*.

That is *true*, in *matters of Taste*, which is *consistent with the laws of beauty* founded upon the *relations* of *things actual*—and *that* is true in *Morals* (in the highest and best sense, in which it is good);—*that* is *true*, in this sense, which is *consistent with what is to be found in the* GREAT SOURCE OF ALL GOOD. Or in general—due regard being had to its object—it may be asserted, that it is the *perfect consistency* with that which *may be*, or that which *is*, or that which *ought to be*, that constitutes the great characteristic feature of TRUTH.

Objects of Mathematical Research.

(2.) Mathematics, whether pure or mixed, has never to do with *things* as such, but only with the *relations of things*.

This is most manifestly true with regard to number, length, surface, capacity or volume, &c. For there are no such *things* as 2, 3, $7\frac{1}{2}$, &c., separately considered; nor can length, breadth, thickness, &c., exist apart from the things to which they belong, but only that *room* for them, which is to be found in space.

Thus also, mechanical force, motion or (in its qualified form) velocity, rest, time, &c., in so far as we have to do with them, exist not as *things*, but as the *relations of things actual*; and even the earth's orbit no where exists definitely in space; though, being a disturbed ellipse, of known dimensions, &c., it may be accurately prescribed.

(3.) Upon the fundamental fact, thus exhibited, depends the accuracy of mathematical reasoning. For, the relations of things with which it has to do, admit of being accurately ascertained and defined; which can by no means be always asserted of the

inherent properties of the things themselves; i. e., those which render the things to which they belong what they are.

For while the form, size, &c., of a body can in many cases be accurately ascertained, and the supposable mathematical form which that of the body may closely resemble, may have perfectly definite and well ascertained properties, we, as yet, can know very little of the atoms which compose that body, and cannot even assert that, in the strict sense of the word, it is composed of atoms at all.

It cannot then be a legitimate objection to the conclusions of mathematics, that there *are no such things*, as those to which they refer; since those conclusions have not to do with things as such, but with their *relations*, and as stated at the outset, (1.) it is sufficient that even these be *supposable*, constituted as things now are.

The Relations of Things are Matters of Constitution and Arrangement.

(4.) The relations of things already designated are themselves not mere figments of the human mind, but—as all experience teaches us—they are *constituted* relations: i. e., in so far as we have to do with them, their connexion with things actual is a matter of arrangement dependent upon the constitution of the things, or else the things themselves are in some measure constituted in subordination to those relations: or both.

Thus, one part of space is not diverse from another, nor does one day of the week of course succeed another, because we may *choose to think so*, but because the CREATOR has formed (or *conformed*) them so. For "of" HIM not merely are all things, but "by" HIM they also *consist:* or, in other words, HE has not merely made those things with which we are familiarly conversant, *what* they are, but also, in certain respects, *as* they are. Any similarity in the relations of things must therefore also be a matter of constitution or arrangement; and we may safely make use of it in the illustration of one class of relations, by a comparison with another.

Of Quantity and its Distinctions and Ratio.

(5.) *Quantity* is the general term employed to designate all those relations of things which are the subjects of investigation in mathematics. In so far as it is thus employed, it denotes whatsoever admits of the distinction of greater and less.

(6.) Two quantities are of *the same species*, if each, *in itself*, exceeds its less, in the self same respect in which the other, *in itself*, exceeds its less; i. e., the terms greater and less must be applicable, in the case of each, in the self same sense. They must, moreover, be thus applicable to the quantities themselves, and not merely to their boundaries or limits.

Thus a straight line and a curve are of the same species; since each exceeds its less in length—in which respect alone a line can be either great or small. But, a straight line and a square are of different species; since the one exceeds its less in length, while the other exceeds its less in surface; and this, although the boundaries or limits of the square are, themselves, straight lines.

A straight line and an hour are quantities of a different species, since the one exceeds its less in length, but the other exceeds *its* less (e. g., a minute) in duration.

(7.) So fundamental and inherent is the distinction between quantities of different species, that the combination of them by addition, or the attempt to subtract one from the other, or to compare what constitutes greatness in the one species with that which constitutes it in the other, will all be found to be impracticable, and even manifestly absurd.

Thus a straight line cannot be added to a day, nor a pound in weight be subtracted from the surface of a triangle; nor can we say of an hour and a square that one is larger than the other, or even compare them at all as to greatness.

The single point of resemblance between quantities of different species, is that indicated (5.) in the definition already given of quantity in general; viz., that the distinction of greater and less *in some sense*, is every where admissible. Hence it is possible to compare the ratio of two quantities of one species with that of two other quantities of another species; or even that an equality of such ratios should exist; one of the first pair being precisely as great or small in comparison with the other, in the peculiar sense of great or small which belongs to that species, as one of the other pair of quantities is great or small in comparison with the other, though in the peculiar sense of great or small which belongs to *that* species. Thus, 2 feet : 1 foot : : 2 hours : 1 hour.

Of the Limits of Various Quantities, and the Nature of Zero.

(8.) The nature of the boundaries or limits of the quantities of various species will next be considered; and this will naturally lead to an examination of the nature of *zero.*

The limits of bounded space being the most obvious, and also those with which we are most familiar, may well claim our attention first.

Solids, or rather volumes, *occupy* space; and their limits are surfaces. In accordance with what has already been advanced, (2.) it will be observed, that it is with the form, capacity, &c., of the space thus occupied, that the mathematician, as such, has to do, and not with the nature of the substance to which they may appertain.

A surface (i. e., the very outside) of a solid, although it bounds that solid, is yet no part of the solid itself. To remove or even

separately mark out any *portion* of the solid, the region at which the division is made or indicated, must lie beneath the surface. The surface exists only where the solid, or the space occupied by the solid, ends and other space begins. The surface itself occupies space not at all; it only *divides* space. It is not *somewhat*, in the same sense in which the solid is somewhat, but only *somewhere:* viz., where, as already stated, the solid ends, and space exterior to it begins.

The surface, then, having no capacity, is in that respect a *zero* of solidity; and we may with propriety say, when a solid such as a cube or a parallelopiped is reduced to its base (its altitude being reduced to *zero*), that the solid (as such) is reduced to *zero.*

The base or other surface, though thus a *zero* of capacity, is yet *somewhat* in its own sense—in the sense peculiar (6.) to that species of quantity—viz., *in superficial extent;* i. e., it still possesses, as it were, the property of covering or extending over, as well as limiting, a portion of the solid, and also that of *dividing* space.

But *a line* existing at the edge of such a surface, or any other, is not *somewhat*, even in the sense last mentioned, but only *somewhere:* viz., at the very edge of the surface. It does not *divide*, but only *penetrates* space.

If then a figure, such as a parallelogram or triangle, be reduced to its base (its altitude being reduced to *zero*), the surface of that figure will be reduced to *zero;* or the base having no surface, will be in that respect *zero; i. e.*, *zero* of *surface*, or of area, which is measured surface.

A straight line whether it thus exist as the edge of a surface or be otherwise defined (e. g., the axis of a sphere), is yet *somewhat* in its own sense—in the sense peculiar to all lines—viz., in *length;* whereby, though it does not *divide*, it *penetrates* space.

A point, at the extremity of such a line, is not *somewhat* in *any sense*, but *only somewhere;* viz., at the very end of the line.

The like is true of a point, though otherwise situated; *e. g.*, at the centre of a sphere; where it is precisely at an equal distance from any and every point in the surface. This would cease to be true at any other position; though it were even at the smallest distance from the centre: so that this last cannot extend *somewhat* in any direction, nor yet be situated *any where else*, than in the position which has been already defined.

A point is thus the *absolute zero of space;* having "position, but not magnitude."

(9.) As in space there is room for the separate existence of all the material substances with which we are conversant, so, in duration, there is room, in a metaphorical sense, for the (successive) occurrence of events; and time is separated into portions, or has their termination marked by the limits of duration, as space is

divided or limited by its bounding or limiting surfaces; or as a line is divided into distinct portions or is terminated by a point. When the one analogy will be the more complete, and when the other, will the more distinctly appear, when the infinities of both space and duration are considered in their proper connection. It will however be observed, that a limit such as the midnight with which one day (according to the ordinary reckoning) ends, and another begins, is not *somewhat* in *duration*, but only *somewhere;* or rather—if such a word were admissible—*somewhen;* viz., *when* the one day ends and the other begins. A limit such as this is *an instant;* and its relations to duration, or to that measured or at least finite portion of it, which we call time, are analogous to the relations of point to space. An instant is the *absolute zero* of *duration*, as a point is the *absolute zero* of *space.* [An instant is different, therefore, from a *moment;* which is a small but indefinite *portion* of duration.]

(10.) Rest, is, in a manner sufficiently analogous, the *zero* of *motion;* and may exist as the effect of an equilibrium; which is rest compelled.

This *zero* occurs, when *and* where, the body comes to, or is found at, rest; or when *and* where, it is prevented from moving.

(11.) An *equilibrium* is itself one form of the *zero* of *force;* though *such* a *zero* may simply imply the absence of *all* force, from a given *place*, and at a given *time: when* and *where*, there is *no* force.

(12.) *Perfect shadow* is the *zero* of *light; whenever* and *wherever*, it may exist.

(13.) Lastly. Empty space is itself the *zero* of *matter;* however great that space may be in capacity.

(14.) In any and all of such cases as have been specified, *zero* implies the absence of *that to which it is related;* and point being no extent in space; an instant, no time; rest, no motion; &c. Yet, an instant seems to be almost as incomparable with a point, as an hour with a mile. Being related to quantities entirely unlike in kind, each alone has place (in its own peculiar sense of the term) in that species of quantity of which it is itself the *zero.*

A point, however, may have place in a line, which itself, as before shown, may be a *zero* of surface, and this surface, again, a *zero* of capacity; for the point, the line, the surface, and that which the surface limits, are all to be found in space itself. But the other *zeros* which have been specified, an instant, rest, equilibrium, shadow, and (with reference to matter) empty space, though any or all of them may exist *when*, if not *where*, and sometimes even, *when and where*, all the *zeros* already described are found, yet the presence or the absence of one will not, in every case, imply, or require the presence or the absence of another; and the relations of all, as well as those of other *zeros* will, when

carefully considered, lead to the conclusion, that *zero* is, in *no* case, to be regarded as the absence of *all quantity*—for then there could scarce be any occasion to consider it at all—but only as, in any case, *the absence of the quantity in question.*

[If then we should conclude, from considerations abundantly adequate, that before all that we here call somethings, there must have existed that which is not something; what we thus arrive at cannot be represented as a *zero*, except in the very respect that is *not something*, as the others are; but, even in so far as these considerations, thus exclusive, can determine, that which was before all these somethings may have been, and still may be *infinite* in its own way.]

Has Motion any place in Pure Mathematics?

(15.) What has already been said of a point, or the *absolute zero* of *space*, and rest, or the *absolute zero* of *motion*, may be found to have prepared the way for the consideration of the question:—how far, if at all, motion may be predicated of a *mathematical* point; or indeed, how far motion may have place, when what is to be moved, is a point, a line, a surface, &c., or any other quantity of those specially recognized by geometers.

Motion is *progressive* change of place. A body changes its place, as soon as it begins to move; *i. e.*, it *forsakes* the place which it occupied in space. It is transferred during the motion from place to place; and when the motion has ceased, the body is at rest; *i. e.*, no farther change of place occurs, but the body continues to occupy the place to which, at the end of the *progressive change*, it was transferred. The body itself was thus transferred, and not the place occupied by it: and all the boundaries, limits, or points situated in or about that space would be found to retain their positions, upon a reference to fixed standards. Neither space, then, nor the limits of it, are found to be the subjects of motion; that being, in so far as we can investigate it, a *physical* property of body, or, at most, of that which is in any sense connected with a body; as in the example of our own selves.

Yet a point, under certain circumstances, is, *as it were*, transferred along a line.

Thus when a pyramid so moves as to change the position of its vertex, the *mathematical* point at that vertex, is successively to be found at different places in the line which marks the limit of the whole space, either occupied, or passed through by the solid.

It should, however, be borne in mind, that a *mathematical* point, as already described, (8.) is not somewhat *in any sense*, but *only somewhere;* and the *place* of the point, in this instance, is precisely where the *pyramid ceases to be found at all*, and ex-

terior space begins. Now as the pyramid, during its motion, continually *forsakes* the place it may happen at any instant to occupy, the point at the vertex being just *without* the pyramid, or at the limit of the space thus occupied, will be at once *left behind;* the motion by hypothesis being such that the vertex should not be stationary; i. e., the particular cases of a rotation about the vertex, without a progression from its position in space, being excluded. That the *mathematical* point at the vertex will be thus *left behind* or forsaken, will moreover appear, incontrovertibly, from the fact that its position as determined by fixed standards of reference will be found to be invariable.

It is nevertheless true, that the line in which, or precisely *at* which, the vertex, during the motion, is always found, will be distinctly marked out; it being the limit *up* to which that space extends, which was either occupied or passed through by the pyramid.

The like must be true of the centre of gravity of a sphere in motion through space, or which has so moved. A *new* point in space will be found to be the position of the centre of gravity, as the sphere advances. Still more obviously must the like be true of the centre of gravity of two or more bodies, when they so move as to change its position, that centre moreover being throughout supposed to be without the bodies themselves. When the masses, &c., of the bodies are known, the successive positions of the centre of gravity of two or more may be computed, or even prescribed; yet such a mere position, at any instant in space, is not *pushed* forward or *drawn* backward by or with those bodies; and all this, while, moreover, the entire curve in which all the successive (but certainly *different*) positions of the centre of gravity are situated, may throughout admit of being accurately defined, and its limits therefore precisely settled. Indeed, lastly, should we suppose the contrary to all this to be true, we could not escape from the seeming contradiction, that a point which (8.) is the *absolute zero* of space should become *somewhat* in space, that is, should be drawn out into a line which has length, by the introduction of the *foreign* element of motion.

We must, in view of all that has been advanced, regard the motion of a *mathematical* point, as a pleasant fiction; the result as regards position, magnitude, and of the quantities concerned, being the same as it would be if such motion were possible; while the actual description of a *mathematical* line in space would require the motion of *a pointed atom*, if such a thing may be.*

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* This does not militate against the *mathematical* existence (1.) of such curves as the cycloid, &c.; since it is only necessary to suppose the generating circle, or other curve, &c., to be drawn on *a material substance;* that it take successively the several positions required; and that the point at the edge, or elsewhere, be assumed successively where the describing point ought to be.

This fiction may not however be wholly harmless, when not merely *mathematical*, but also physical relations are the subjects of investigation. Such is the case in mechanics, when motion becomes the subject of investigation as a *physical* property, as which alone, in accordance with what has already been said, is it in any case (in effect) to be regarded. The motion of a body involves then the motion of its atoms, and as there can be no moving *mathematical* point, a moving point, or whatever in mechanics may be spoken of as such, must be a *moving atom*. Its physical property of motion, the laws which regulate it, and those which determine an equilibrium, must be made to rest upon observation, experiment and induction.*

Corollary.—There can be no "*Rational Mechanics*," in the sense in which that phrase is often employed.

The considerations already urged, against the doctrine of the motion of a *mathematical* point, will apply with equal force to the case of a *mathematical* line, surface, or solid.

Fundamental Reason for the Existence of Incommensurability.

(16.) From the consideration of limits, zeros, and their special relations, we may pass to that which supposes the introduction of new limits; viz., the division of quantities into parts or portions; fractions, properly so called, among the rest; by the aid of which, the nature of incommensurable quantities and the necessity for their existence may both be made apparent.

If we select as a very simple example, a finite straight line; and suppose it to be divided in the middle, into its two most simple fractions; viz., its two halves; each half will, of course, be equal to the other. When we divide the same line into thirds, three fractions will be obtained, all equal among themselves. The same perfect equality of the parts will still be found when we successively divide the line into fourths, fifths, &c.; any one of such fractions being an *aliquot* part of the whole; and any fraction, such as $\frac{3}{4}$, $\frac{5}{7}$, &c. of the line, a combination, or grouping together, of such *aliquot* parts.

Now, however many such divisions of the whole into all the several fractions of the series of halves, thirds, &c., may be made, it must happen, if the process be far enough continued, that some of the points of division will agree, ($\frac{3}{4}$ of the whole being equivalent to $\frac{6}{8}$ of the same, &c., &c.;) and there no new division of the line will take place. Yet some must also differ, at each new division; since $\frac{1}{2}$ cannot $= \frac{1}{7}$, nor $\frac{1}{3} = \frac{1}{4}$, &c.; and very many other combinations, such as $\frac{2}{3}$, $\frac{3}{4}$, &c., must be different, as the

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* The French phrase, "un point matériel," is descriptive of the real state of the case; whatever may be said of the reasoning in connection with which that phrase may sometimes occur.

theory of numbers would indicate. *However many divisions* into *aliquot parts* may then be effected, there always must be positions on the line, included between the points of division so obtained; since no two of the successive divisions of the whole line can agree, as has already been shown, at *all* points. In other words, there must exist positions between the points of division so obtained, which no division of the line into fractions, (i. e., *aliquot* parts or their aggregates,) *however numerous*, can ever mark. At any or all such positions, the line would be divided into two parts *incommensurable with the whole*, and of course *incommensurable with each other*.

The combination, by addition, of the original line or unit and a line equivalent to such a portion, would be of a length which may be represented as between 1 and 2 such units, but the excess above 1, such as cannot be expressed by any fraction, &c., &c.

The like principles must be applicable to the case of any other quantity which will admit of the like successive fractional division.

The fundamental reason for the existence of incommensurable quantities seems, then, to be, more concisely, this: The division into fractions is a division into *aliquot* portions, or implies such a division of the whole as the aggregate of such portions would furnish. Now this is so far from being the only mode of originally dividing the quantity, that it must be regarded as a peculiar and restricted one; in so much that it would almost seem that the result of a fractional division is not that which would most probably be obtained, if the quantity were divided at hazard; or the chances would be more numerous, that the quantity would be divided incommensurably, than that it would be divided into fractions properly so called.

(To be continued.)

ART. XVI.—*Notes on the Geology of Charleston, S. C.*: by F. S. HOLMES, Corresponding Member of the Acad. of Nat. Sciences, Philadelphia.

THAT Charleston, the Capital of South Carolina, is built upon geological formations identical in age, and in other respects similar to those upon which the great cities of London and Paris are located, is a curious fact but lately ascertained. The basin shaped depression of its underlying calcareous and other beds, as determined in the survey just made by Professor Tuomey, occupies a considerable extent between the Savannah and Peedee Rivers, and rests upon an older group of rocks known to geologists as the Cretaceous formation. The sides of this basin are estimated to be of sufficient inclination to produce those artificial fountains,

which are procured by boring, and known as "Artesian Wells," through which by hydrostatic pressure, the water is forced up to, if not above the surface.

This basin seems destined to become as famous in the eyes of the scientific world as that of Paris, from the number of new and interesting fossil remains with which it abounds, while those of them already exhumed claim for it a rank above that of the London basin.

The tongue of land upon which Charleston is built, was originally a flat peninsula, having Ashley River on the West, and Cooper on the East; these uniting to the south of the city form the bay and harbor, which discharge their waters into the ocean about six miles below. There were five creeks which emptied into Ashley, four into Cooper, and but one at the point of the peninsula. These have all been for the most part filled up and built upon; and the few slight ridges of yellow sands which extended from river to river in lines from N.E. to S.W., parallel to that of the sea coast of this state, have been leveled for the same purpose. Strikingly developed in the Sea Islands, these ridges are a characteristic feature of the lands bordering upon the ocean, and are known as the yellow sand hills, which produce the fine long cottons in such perfection. In appearance they resemble the ground swell of the ocean observable on our coast when the wind is from the east. And it is to this ground swell that I am disposed to attribute their formation; and not entirely to the drift sands which compose the dunes or small islands found between them and the ocean, and skirting nearly all the sea islands.

The sands of the dunes are white or grey, whilst these are yellow, being colored by a slight mixture of yellow clay; the dunes are irregular, lying in every direction; these form long parallel ridges with valleys, which have been denuded of their coverings by the action of the currents and easterly winds alluded to above.

As you approach the coast the hills are highest, and they gradually lessen as you recede towards the main land, which is generally level except immediately upon the creeks and rivers. Sometimes these ridges are found slightly developed upon the main, where the land is open to the sea; but they are as inconsiderable there as those which existed in Charleston. As the gray sands do not produce the long cottons in perfection in adverse seasons, the plantations of the interior and inner sides of the islands, and those also of the main land are considered much less valuable. The formation of these ridges must have occurred when the land was gradually emerging from the sea. The dunes which compose the small belts skirting most of the Sea Islands, serve as barriers for the protection of the latter from the advances of the

ocean, and are separated from them by narrow creeks often with flats and salt marshes on their sides.

Several of the Sea Islands have no such separate barrier, but the sand hills or dunes lie along their ocean side.

It is generally supposed that the sea is rapidly advancing upon our shores, from the fact of these belts having become narrower, and because in some places along the line of coast the sea has encroached considerably; but from several observations made at different times and under favorable circumstances, I am convinced that this is not generally the case, but that if the ocean does wash off portions of the shore at one exposed point, it deposits the same at no great distance upon another. Let us take for example the islands at the entrance of Stono Inlet. Look at the old maps, and you will find that the southernmost point of Bird Key, (a cluster of dunes sometimes called Brown's Bank,) formerly lay some distance within the line of coast formed by Folly Island on the N.E. and Kiawah on the S.W., and had a considerable bay or inlet between the breakers and its south side, while the channel or principal entrance to Stono River passed between it and Kiawah Island. Compare this state of things with the situation of the Key at the present day. The north side now corresponds with the south line of coast of the two islands, Folly and Kiawah; the main channel passes between Folly Island and the Key on the opposite side to where it formerly was, and the principal bay is on the north instead of the south.

But let us consider the causes of these changes. From three several visits in as many consecutive years, made for the express purpose of observing and recording the modifications and changes which have been, and are still in progress at this interesting point of our coast, I infer that the principal agent in their production has been and still continues to be the current of the ebb tide of Stono River. This stream just before its entrance into the bay, receives the waters of Kiawah River, which, contributing greatly to its force, undermine and carry off the sands from the north side of the Key, and gradually increase the depth and width of the passage between it and Folly Island. This channel is now the most direct course of the river to the ocean, but formerly having been greatly obstructed by the north end of the key, the current was, in consequence, turned aside and passed around the point of Kiawah. A portion of the sands thus removed, have been deposited on the south point of the Key, again to be cast up by the surf and formed into hills or dunes by the prevailing sea breeze, and the rest have been added to the immense banks now in course of formation to the south of Kiawah Island, extending from its beach out to sea for one or two miles, and in length about three. Those banks are now entirely covered at high water; but a few years only will suffice, at the

present rate of increase, to raise them entirely above the level of the ocean.

Another important agent in producing the modifications under consideration is the prevailing easterly winds, disposing these sands to be ever shifting from the windward to the leeward, and causing them to move despite all opposition, at a steady though almost imperceptible rate.

At my second visit to the Inlet in the summer of 1846, I observed that a fragment of a ship stranded upon its bar (part of the hood or poop-deck, painted green) had drifted in at high tide and lodged on the Key to the leeward of one of these dunes, the base of which was about thirty feet wide, and at the time I first saw it was being rapidly covered by sands blown over from the windward or ocean side.

On my second visit in the spring of the following year, I found about three feet of one of the planks of this fragment protruding from the opposite side, the hill or dune having nearly passed over it. How much remained covered, I had no means of ascertaining; the fishermen who frequent the island, had cut up and used the exposed part as fire-wood, thus destroying the ends by which alone I could have formed an estimate. The planks, with the single exception mentioned, were cut even with the sands; and as I had no suitable implement for the removal of the latter, I had to content myself with a superficial examination.

A similar incident was related to Professor Tuomey and myself, when we visited this neighborhood together. A raft of boards had drifted upon the inner side of Kiawah point, and lodged on the flat at the foot of one of these hills, by which it was soon covered, and after the lapse of some time, the length of which was not remembered, it was seen to protrude from the opposite side.

The surf has made considerable breaches in the islands of Folly, Coles and Kiawah, to the enlargement of which the waters from the creeks in the rear of the two last named have contributed in no slight degree. But the sands from these have only been removed, to contribute to the formation of the large bank, to which I have already alluded.

Let us now resume the examination of the formation underlying the city of Charleston, as developed by the auger used in boring the artesian well, and also as exposed in the creeks and rivers of the vicinity. Beneath the ridges of yellow sand which have been described, is a stratum of red ochreous clay, provincially termed by the planters, "iron-ore clay," which covers another of white and grey sands, that are sometimes found also between the clay and the yellow sand above. From these strata, which seldom extend twenty feet below the surface of the city, is the "pump-water" obtained. To define the line of separation

between the alluvium and diluvium, (if both are here,) I shall not attempt, but leave it to more skillful hands, with a single remark.

At Ashley ferry, ten miles N.W. of Charleston, the stratum of red, or "iron-ore clay," with its thin seam of grey sand, is exposed in a section of the river bank, resting immediately upon the Eocene marl, while under the city a bed of Post-pliocene intervenes. I infer this to be the same as the deposit of clay in Georgia, of which Mr. Lyell speaks, and from which he obtained the grinder of the mastodon, and Dr. Habersham bones of that and other extinct mammalia. Mr. Lyell represents it as "resting immediately on sand containing marine shells of living species," which sand, I should infer, corresponds with the Post-pliocene bed of South Carolina.

I have never found any teeth or bones in this clay, but fragments of the grinders of the mastodon, with gravel and drift from the river lodged in the holes of the surface of the Eocene marl exposed in the bed of the river, have often been found by myself and friends, and it is quite reasonable to infer that they were washed out of the clay by the current. Some years ago I found portions of a large bone which I supposed to be a femur of a mastodon or other large mammalian, in a cavity on the surface of a Post-pliocene bed, with the clay immediately above it. These specimens are now in my cabinet.

The next in the order of descent is the blue mud and sands, with shells of the Post-pliocene formation, to which allusion has just been casually made. This is the newest of the tertiary; sometimes the blue mud is missing, and laminated sands and clays are mixed with or cover the beds of shells.

The testacea of this bed, whose analogues are supposed by Mr. Lyell and some other geologists, to be those now living in the neighboring waters, lie in patches filling the depressions and irregularities of the surface of the Eocene marl, upon which they are *always* found immediately to rest. I say *always*, because I have never seen the Miocene underlying the Post-pliocene in the order of superposition, but in every exposure that I have examined, the Eocene has been so found.

The two Miocene deposits near Charleston, are covered either with diluvial sands, or the alluvium of the rivers; whence I infer, that during the deposition of the Post-pliocene, these patches of Miocene must have been above water, or were denuded of their Post-pliocene covering previous to the deposition of the diluvial or alluvial sands and clays.

With but a single exception, the Post-pliocene is never above the level of high water. In a well dug on the side of a run, about a quarter of a mile inland from Ashley ferry, and ten miles N.W. of Charleston, shells of this formation have been exposed. I accompanied Professor Tuomey, late state geologist, in the ex-

amination of this deposit, and assisted him in taking its level. As there was much water in the well, this point could not be accurately determined; but it was estimated to be at least three feet above high water mark.

The low country of South Carolina is well watered by a number of bold streams, which for the most part, are connected a few miles above their mouths by creeks passing between the sea islands of the coast and the main land, providing a safe and continuous inland passage for steamboats and small craft, from Georgetown to Savannah. In one of these passages, the most extensive exposure of the Post-pliocene and its superimposed diluvium or alluvium may be seen at the plantation of William Simmons, Esq., on Yonge's Island, about twenty-five miles S.W. of Charleston; it is separated from Wadmalaw Island by the river of the same name, (sometimes called "the Sound,") which also unites the waters of the Edisto and Stono rivers. The rapid current which sets in upon the bluff of Yonge's Island, sweeps off with every southeasterly gale, portions of this noble bluff, carrying with it the cotton plants that grow in the field above, the level of which is about twenty-two feet in its highest part from the surface of the shell bed forming the beach at its base.

Most of the shells in this bed are in a perfect state of preservation, and when denuded as they are for a great extent, of their covering of sand and clay, are seen in clusters of a dozen or more, each species forming a little colony or family, occupying the positions in which they lived and died. The adaptation of the mud in which they are imbedded, and which is so suitable to the habits of the testacea, is beautifully exemplified by the fact of recent species taking up their abode in it; and hence the difficulty sometimes, of determining the recent from the fossil of the same species; the dead shells of the former being often found in the same patches with the latter.

The first specimen of Pholas costata discovered, was put down in our catalogue of fossil species, and it was not until many visits had been made, and the bed dug up one or two feet, that the living ones were found. Two species of Pholas, (P. costata and P. truncata,) with Petricola pholadiformis, are abundant. Occasional specimens of Pholas oblongata are also to be had. Thus we were obliged to discard many fine specimens as recent, which had been preserved as fossil. The living Ranella caudata, Venus mercenaria, and Cultellus caribœus, have also been found at this locality.

The characteristics of the Post-pliocene testacea, are supposed by Professor Agassiz, who examined cursorily a few of the most prominent specimens in my collection, to be indicative of specific differences from those of similar forms now inhabiting the waters of the coast. I acknowledge my obligations to this gentleman,

for pointing out discrepancies which hitherto had escaped observation, but which the microscopic eye of the "Neufchatellian Naturalist" at once discovered. The splendid Mellita, the admiration of all who have seen it, resembles in its external form the recent Mellita (Scutella, *Lam.*) quinquefora of the coast, and has always been considered identical. The latter has never been found over five, or perhaps four and a half inches in diameter. I have never seen one so large; they seldom exceed three and a half inches on this coast; whereas this fossil will average eight inches. Many are found of nine, but not one less than five inches in diameter, and of this last size few are to be had. At the suggestion of Prof. Agassiz, I will call it *Mellita ampla*, it being the largest known of any species in the world, and shall describe it, with its characteristic differences, in the Journal of the Academy of Natural Sciences, of Philadelphia, together with other new shells from the beds of the Charleston basin.

The following catalogue contains one hundred and forty-seven species of Post-pliocene fossils now in my collection, and that of my friend, Dr. Thos. L. Burden. They were all of them obtained from the exposures of Yonge's Island; Abbapoola creek and Ratlin's bridge, John's Island; Submarine bed, Stono river; John Hamblin's, Esq., Christ Church Parish; and at the plantations of A. H. Brown, Esq., Old Town Creek, and Joseph F. Bee, Esq., Ashley Ferry, St. Andrew's Parish.

POST-PLIOCENE FOSSILS OF SOUTH CAROLINA.

1.	Dentalium politum.		27.	Tellina polita,	Say.
2.	Spirorbis sps.?		28.	T. brevifrons,	Say.
3.	Teredo navalis,	Lam.	29.	T. flexuosa,	Say.
4.	Serpula.		30.	T. lusoria.	
5.	Coronula dentulata,	Say.	31.	Corbula contracta,	Say.
6.	Balanus ovularis,	Lam.	32.	Lucina punctulata,	Lea.
7.	Pholas costata,	Lin.	33.	L. crenulata.	
8.	P. oblongata,	Say.	34.	L. divaricata,	Lin.
9.	P. cuneiformis,	Say.	35.	L. trilineata.	
10.	P. truncata,	Say.	36.	L. sps.?	
11.	Solen ensis,	Lin.	37.	Astarte lunulata,	Con.
12.	S. viridis,	Say.	38.	A. sps.?	
13.	Solecurtus caribœus,	Lam.	39.	Cyrena carolinensis,	Say.
14.	Lutraria canaliculata,	Say.	40.	Donax variabilis,	Say.
15.	L. lineata,	Say.	41.	D. fossor?	Say.
16.	Cumingia tellinoides,	Conrad.	42.	Byssomia?	
17.	Crassatella, sps.?		43.	Cytherea Sayana.	
18.	Mactra lateralis,	Say.	44.	C. gigantea,	Lam.
19.	M. similis,	Say.	45.	C. obovata.	
20.	Mya arenaria,	Lin.	46.	Artemis concentrica,	Born.
21.	Gnathodon cuneatum,	Gray.	47.	Venus mercenaria,	Lin.
22.	Amphidesma equalis,	Say.	48.	V. permagnum.	
23.	Sanguinolaria fusca,	Say.	49.	V. cancellata,	Lin.
24.	Pandora trilineata,	Say.	50.	V. elevata,	Say.
25.	Petricola pholadiformis,	Lam.	51.	Cardium muricatum,	Lin.
26.	Tellina alternata,	Say.	52.	C. Mortoni,	Con.

53. Cardium ventricosum, Brug.
54. C. isocardium, Lin.
55. C. marmoreum, Lam
56. Cardita tridentata, Say.
57. Hiatella stonoensis.*
58. Arca transversa, Say.
59. A. incongrua, Say.
60. A. pexata, Say.
61. A. ponderosa, Say.
62. A. lienosa.
63. A. cælata.
64. A. Buckleyii.
65. Pectunculus glycimeris.
66. Chama congregata.
67. Nucula limatula, Say.
68. N. acuta, Con.
69. N. proxima, Say.
70. Pinna seminuda, Lam.
71. P. muricatum, Lin.
72. Pecten dislocatus, Say.
73. Lima, sps.?
74. Avicula atlantica, Lam.
75. Mytilus lateralis, Say.
76. Ostrea fundata, Say.
77. O. equestris, Say.
78. O. virginiana, List.
79. O. wadmalawensis.*
80. Anomia ephippium, Lin.
81. Plicatula ramosa, Lam.
82. P. cristata.
83. Hyalea Tuomeyi.*
84. Fissurella alternata. Say.
85. Infundibulum centralis.
86. Crepidula fornicata, Lin.
87. C. depressa, Say.
88. C. plana, Say.
89. C. convexa, Say.
90. C. cornucopia, Lea.
91. C. aculeata, Gm.
92. Bullina canaliculata, Say.
93. Auricula bidentata, Say.
94. Eulima, sps.?
95. Natica duplicata, Say.
96. N. heros, Say.
97. Acteon?
98. Sigaretus perspectivus, Say.
99. Columbella avara, Say.
100. Columbella, sps.?
101. Planorbis trivolvis, Say.
102. Pyramidella suturalis, Lea.
103. Pasithea eburnea, Lea.
104. P. exarata, Lea.
105. Scalaria clathrus, Lin.
106. S. lineata, Say.
107. S. angulata, Say.
108. S. multistriata, Say.
109. Cancellaria reticulata, Lin.
110. Oliva literata, Lam.
111. O. mutica, Say.
112. Littorina irrorata, Say.
113. Nassa obsoleta, Say.
114. N. vibex, Say.
115. N. trivittata, Say.
116. Buccinum acutum, Say.
117. B. lunatum, Say.
118. B. sps.?
119. Marginella limatula.
120. Cerithium dislocatum, Say.
121. C. monoliferum, Lea.
122. C. sps.?
123. Pyrula carica, Lam.
124. P. perversa, Lin..
125. P. canaliculata, Lin.
126. P. pyrum, Dill.
127. Fusus cinereus, Say.
128. Fasciolaria distans, Lam.
129. F. (Trapezium) gigantea, Kiener.
130. Ranella caudata, Say.
131. Strombus pugilis. Lin.
132. Delphinula, sps.?
133. Ovula acicularis, Lam.
134. Rotella.
135. Trochus philanthropus, Con.
136. Nodosaria.
137. Echinus punctulatus, Lam.
138. Spatangus atropus, Lam.
139. Mellita ampla.*
140. Astrea, sps.?
141. Alveolites glomerans.
142. Lunulites denticulata.
143. Teeth of Carcharodon.
144. " " Lamna.
145. " " Notadanus.
146. Palatal bones of Myliobatis.
147. Crabs' claws are also numerous.

The Strombus pugilis, No. 131, is not known to me as an inhabitant of these waters, but it is abundant in the Floridian and West Indian seas; and the only locality from which the beautiful Astarte, (No. 38,) has been obtained in a living state, is on the coast of California. It would, therefore, appear that the climate

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* Not yet described.

of South Carolina has changed, and the waters of the coast become too cold and uncongenial to these testacea, if, as some suppose, they are of the same species.

Other interesting geological phenomena are displayed in this inland passage of Wadmalaw Sound, which demand some notice. Beginning at Bears Bluff on the west, where it connects with the Edisto river, and ending at Wappoo cut, on Stono river, to the east, there is no portion of it that does not impress upon the mind of the most careless observer, the conviction that it was once an extensive fresh-water swamp. Stumps and logs of the largest cypress and cedar trees (*Cupressus disticha* and *Juniperus virginiana*) are met with, throughout its extent. There are persons now living, who remember when parts of this passage could only be navigated by canoes, where now some half dozen steamboats could lie abreast, and where there is water sufficient to float a frigate. Throughout its extent, but principally about midway of this passage, its navigation is greatly obstructed by mud-flats, which are exposed at half-tide, and can only be passed by vessels of light draft, and at high water. The salt marshes extend from the river to the high land on both sides, and vary from a few yards to a mile in width; and their surface is slightly covered by every tide.

But the most interesting feature is the hundreds of little "cedar islands," as they are called, whose soil, composed of vegetable matter, partly decomposed, is only one foot deep, and rests upon the mud on which grows the salt marsh. The spring tides flow over them, but the ordinary tides, rising only above the marsh land, surround and undermine the small cedars found growing there in great numbers, whose lateral roots being confined to a light superficial loam, the stunted trees are compelled to yield to the destructive agent, so that the whole space is filled with their living and dead, or dying trunks. The larger ones with tap-roots descending deeper than the superficial loam, remain erect after death; but there are hundreds that are prostrated often whilst alive, and that lie just where they fell, with their trunks directed outwards. These, as soon as their small limbs and sappy parts have rotted, become imbedded in the salt mud; and the islands on which they stood being eventually deprived of their covering of vegetable loam, a growth of salt marsh speedily springs up.

Undoubtedly these islands were once occupied by the large cypress trees, whose trunks and stumps (many of the latter erect) are now found in numbers in the soft mud around. When the barriers to the ingress of the salt waters of the Edisto and Stono rivers were originally destroyed, they did not immediately cover the whole of the swamp in question; but after providing a channel for themselves, they must at the return of every tide have gradually increased in width, and thus carried off more or less of

the superficial vegetable deposit in the manner already described. The large trees having their tap-roots below the loam, were first killed, and many of them being exposed for a long time as erect dead trunks, were broken off by gales, which left the stumps in the position in which we now find them. The mud below becoming very soft, permitted these to sink into it and become imbedded, leaving the peaty loam above them in the possession of small cedars, the former undergrowth of the swamp.

May not many of the instances to be met with along the seaboard, and which have been cited by geologists as cases of subsidence, be referred to the operation of similar causes?

Off the beach at Coles Island, about one hundred yards from shore, are several stumps of oak trees, erect, surrounded by beds of oysters (O. virginiana) and only exposed at low water. Among them is one trunk of a live oak, (Quercus virens,) about eight feet high, over the top of which the tide at its highest does not rise, presenting a most singular, but interesting sight, when the heavy surf at high water is rolling around it. On a calm day, during one of my visits to this spot, I moored my boat to it whilst making observations in the survey of the inlet.

Next in order as we descend below the Post-pliocene, under the city of Charleston, is the Eocene, or lower Tertiary; the first stratum being an olive-colored peaty substance, resting upon another of sand, that separates it from the great marl-bed below. This stratum of sand contains a quantity of water, which, in the boring of the Artesian well, rose in the tubes to within six feet of the surface, and greatly obstructed the progress of the auger by filling it with quicksand.

Inbedded in the peaty substance before mentioned, are numbers of rolled and water-worn rocks of all sizes, from a few inches to a foot in diameter; a fresh fracture in any of which discloses the same forms of fossils as are seen in the great marl-bed below, of which, no doubt, these are fragments, broken off by the action of the sea, and rolled into bowlder-like masses; their nature changed by some chemical process, whereby nearly all the lime has been extracted, and the casts of the shells are left preserved in a silicious rock, emitting when broken a fœtid odor. The causes which produced the separation of these fragments, and the subsequent deposit of them in a distinct stratum one foot thick, are yet undetermined. The fragments are much larger where they crop out on the surface, ten miles north of the city, than they are in the part of the basin immediately beneath it.

These strata, including the first ten feet of the underlying marl, may be properly called the "Zeuglodon" or "Basilosaurus" bed of the "Charleston basin," which Professor Agassiz has pronounced "the richest cemetery of animal remains that he had ever

seen." From it was taken the most perfect skull yet found of that wonderful gigantic fossil cetacean; and by which was determined the true character of this singular animal.

Isolated teeth and bones of Basilosaurus, Dinotherium, Megatherium, Equus, and nearly fifty species of sharks, are obtained in abundance, as are also bones of a large Chelonia. I have in my cabinet three links of the vertebræ of Mosasaurus, "the great animal of Maestricht," a cretaceous fossil which I obtained in the marl of Ashley river. The number of undetermined teeth and bones is considerable. Two specimens of walnuts, with the epidermis converted into lignite; three casts of hickory-nuts, very perfect and beautiful, and fragments of wood, (now lignite,) bored by the Teredo, whose casts in marl are yet preserved, have been also obtained; and at every visit something new is added to my stock.

Few shells are preserved in a perfect state, but casts in the marl of many genera and species are easily obtained in the upper beds. Of the perfect specimens, "Balanus peregrinus" *Morton*, "Gryphæa mutabilis" *Morton*, Anomia rugosa, and Scalaria Sillimani *Morton*, may be said to be abundant; whilst one hundred specimens of a species of coral, (Anthophyllum atlanticum, *Morton*,) can be obtained from a cubic foot of this marl: it is the most abundant fossil of the Ashley bed.

There is one other class of fossils characterizing the marls of Ashley and Cooper rivers, which, though of the most diminutive forms, are no less wonderful or interesting; I allude to the Polythalamia, (composed of many cells,) beautiful little shells, which are generally microscopic; but many species of several genera, sufficiently large to be examined by the naked eye, are quite common. My cabinet contains a fine suite which I collected from the borings of the Artesian well. The matrix inclosing these shells is, itself, a mass of Infusoriæ.

Professor Bailey, of West Point, (to whom I sent specimens for examination,) writes me that he has placed a good supply of the Charleston marl in the hands of Ehrenberg, and requested him to determine the species, which labor he has undertaken; but his results are not yet published. Of those which I sent Professor B., many were destroyed before reaching him; among the remainder he distinguished forms of the following genera: Robulina, Cristellaria, Dentalina and Nodosari. "These," says he, "are *giant* specimens of their kind, being vastly larger than the forms which I had previously studied in the marls of the wells in your city."

The fossil, mineral and other characters of the marl of Ashley and Cooper rivers, differ considerably from those of the Santee beds belonging to the same formation, which out-crop at various points between those rivers and the Santee. The fossils too of the first do not indicate as great an age as those of the last, and no green sand nor extensive veins of water have yet been found

in the Ashley and Cooper river marls, though this fluid oozes slowly and in small quantities through every part of them.

The most wonderful feature of this older bed is the number of subterranean streams of fresh water by which it is traversed. The surface of the Santee region abounds with funnel-like depressions, called lime-sinks; caused, apparently, by the falling in of the marl and superincumbent soil, which had become too thin to support its own weight, from the washings of the stream beneath. Instances have been known of the ploughman, with his team, being engulfed by the sudden falling in of one of these lime-sinks.

During the spring of the present year, the swamps having been dried up, and the rivers reduced to a very low state, from the drought which had prevailed all winter, I availed myself of the opportunity thus afforded of examining the exposures of marl on the water-courses of this region, and also some of its beautiful springs, or subterranean streams.

Woodboo, a plantation belonging to the estate of the late Stephen Mazyck, Esq., is remarkable for two springs, the vent of one or perhaps two of these subterranean streams. The waters flow from openings in the marl, four or five feet in diameter, at the bottom of a basin, the area of which is several hundred feet; and so beautifully clear and transparent are they, that the trout, bream, and other fish, and indeed objects of the smallest size, may be distinctly seen at the depth of twenty or thirty feet. The bluish tinge of the water, too, casts a sombre, but agreeable hue on all around; and the general effect is not a little enhanced by the willows and cypresses extending their graceful arms above its surface, and studding the banks of a considerable stream which, flowing from the basin in a winding course, empties, at the distance of nearly half a mile, into the Santee Canal, the lower sections of which are dependent upon it for their supply of water.

An incident was related to me in connection with these springs, which will convey some idea of the extent of the subterranean streams of this region, and which, extraordinary as it may appear, a similar and subsequent event, coming within my own observation, leaves me no ground for doubt. I will first relate the one which I witnessed.

Before reaching Black Oak Lock, I was informed that there was a "break" in the canal at this point, by which all the water from one section had escaped, so as to overflow completely a swamp at a short distance from it, where, owing to the drought, no water had lain for some months previous. Supposing that the "break" in question had occurred in the bank of the canal, and that if large enough to permit the escape of the waters of an entire section, it would expose much of the material composing the embankment, I thought myself fortunate in getting such an

opportunity to view the exposed bed, and collect fossils from the mass constituting its margin. But my surprise may be imagined on arriving at the spot, to find a number of workmen surrounding a large hole, or sink, in the *bottom* of the canal, and to learn that that was the "break" by which the waters had escaped. This was produced in the same manner, and was in fact nothing more than a lime-sink, such as I have already described.

Still more singular were the circumstances related to me respecting the Woodboo Springs. Many years ago, a similar "break" or sink having occurred in the canal, it was repaired by driving piles into it, and filling the interstices with fascines made of rice-straw, (then grown extensively in the inland swamps of this neighborhood,) covering these with rammed clay, and planking over the whole. The work, however, having been carelessly performed, did not last long; the piles, fascines, and other material used in the repair, suddenly disappeared, and were followed by the waters of that entire section of the canal. Two months afterwards, to the surprise of those who witnessed it, the fascines of rice-straw came up with the bubbling waters of Woodboo Springs, at a distance of two miles below.

Since writing the foregoing, I have received a letter from Dr. Edmund Ravenel, written, as he therein tells me, upon seeing my report to the city council of Charleston, of a water-bearing stratum penetrated in boring the Artesian well. Coming from one who has lived many years in the neighborhood of the places alluded to, and a naturalist well known for his contributions to the natural history of our state, and for his attainments in that department of science, I have taken the liberty of appending to my preceding account the whole of his letter, omitting only the portion of it which refers to Woodboo Springs, as his description of those springs does not materially differ from that which I have already given:—

"At the next plantation below Woodboo another spring exists, but much smaller, pouring out its beautiful clear water at all times; it has attracted attention from the fact of its communicating, by subterraneous passages, with several openings near each other. It is upon the course of this spring that Mr. Robert Mazyck discovered the 'green sand' rich in Eocene fossils, and considered so valuable as a manure; indeed the most valuable which our marl-beds have yet furnished.

"The plantation above Woodboo, Wantoot, furnishes another extensive spring from the Eocene. The quantity of water thrown out is much less than at Woodboo, although the stream is considerable. There are several openings at various distances in the basin, through which the water issues; and these occasionally become closed, and new ones appear. These openings are all in the Eocene marl.

"Many years ago I observed a spring, quite small, just at the edge of the highland outside of the edge of the basin; and with the hope of getting an opening for the water, which was so conveniently situated for use, I removed the thin stratum of clay so as to expose the marl. I found the water issuing from a very small fissure in the marl; into which I bored with a common carpenter's auger, as deep as the instrument would permit. On withdrawing it, the water spouted up considerably above the surface. I then cut off a portion of my fishing-rod, a large cane, and punched out the joints, so as to make a continuous tube of about six feet. This was inserted in the auger-hole, and luted with clay; and the water immediately ran out at the top of the tube. This continued for several days, until the frequent removal and replacement of the tube made the hole too large to permit me to confine the water to the tube.

"In about a week, or perhaps longer, the opening increased to a foot in diameter, and a rod could be passed down eight or ten feet; and upon dropping a line into it, with about an ounce of lead, fish of considerable size were often caught. I have no doubt that these fish entered at the opening from the basin.

"At 'Pooshee,' near Black-Oak, the plantation of Dr. Henry Ravenel, there are several springs of this character, arising immediately from the Eocene.

"At Chelsea Plantation similar springs exist; and in several places in the woods there are small deep holes, containing clear water, called 'Fountains,' which communicate with openings into cavities in the Eocene marl. North of Pooshee, in the pine land, there are several of these fountains which communicate; the streams, like all those I have mentioned, running south, and emptying into a branch which is known as the 'Fountain Swamp.' These fountains are of the same character as the larger limestone sinks, well known through the marl region. They are caused by streams of water running through fissures or cavities in the marl, which gradually wear away the bed, increasing the cavities; the roofs of which are perpetually falling in, until they become too thin and weak to sustain the weight of the earth above them. When these streams are near the surface of the marl, small portions of the earth sink in, and *fountains* are formed. When the streams are deeper, large cavities are hollowed out below, before the mass above falls in, when the ordinary lime-sinks are formed: frequently these are quite dry, and many of them remain so after the heaviest rains; the water percolating through the earth, and finding its way to the stream, still existing below. At other times the streams are obstructed by the fallen mass, and deep ponds are formed, which have water at all times.

"The famous 'Eutaw spring in the field,' is an instance of a fountain formed by the breaking in of the earth; above one of

these streams, in the marl, near the surface, the water breaking over the fallen mass, fills a small basin, and then finds a vent into the old passage again, which seems to dip considerably as soon as it disappears, showing itself again at a short distance from the spring, in a bold stream known as Eutaw creek.

"Similar springs exist in the neighborhood, and probably in other portions of the Eocene region. The water contains carbonate of lime in solution, which affects its taste, although it is used every where for domestic purposes.

"At the lower lock at Blackoak, on the Santee Canal, the water from 'Pooshee Springs' passes under the lock by a brick aqueduct, the roof of which is never touched by the stream passing through it; and the whole arch is thickly studded with stalactites, formed by the evaporation of the canal water, which percolates through the brick work.

"These springs are outlets from streams of water in the Eocene bed, which are not connected: they are at different depths, and vary in size. Many have been diverted from their course, possibly, by the falling in of their roofs and superincumbent strata of earth, leaving portions of their track dry, and forming caves of greater or less extent, as is seen at 'Cave Hall,' in St. Matthew's parish.

"Some of these streams must be very large, as exhibited by the great spring at Woodboo. In 1815–16, when the supply of water to the upper portion of the Santee Canal failed entirely, so that the canal was dry for many months, the water from Woodboo spring furnished an abundant supply to keep the canal in navigable order from Coalhill lock to Cooper river; and the woodboats continued their business regularly. Between Coalhill and Blackoak, the canal was kept full by the springs from Pooshee, making the canal navigable up to the lower lock of Blackoak.

"This state of things continued so long, that the Canal Company expended considerable sums in experiments, in digging for water into the canal, which all failed. The Artesian well was not attempted; but in boring, if such a stream as that supplying the Woodboo springs should accidentally be entered, an abundant supply would at once be obtained. Unfortunately we have no data to determine the existence of such streams in any particular spot, or their direction; in boring for them, it must be mere chance which could make the experiment successful. Their existence should, however, be always kept in mind, in boring through the Eocene; and whenever a sudden escape of water occurs, it should be attended to, and not shut out by pipes, before its quantity or quality has been tested."

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Art. XVII.—*Description of two Reptiles from Oregon;* by Mr. Avery J. Skilton. (With a plate.)

Read before the Troy Lyceum of Natural History, Oct. 9, and Nov. 13, 1848.

Salamandra (Triton) granulosa, n. s. Tail about the length of the body, strongly compressed and carinated throughout. The animal wholly coarsely granular, except one inch of the tip of the tail.

Color, reddish brown above, orange beneath.

Length five and a half inches.

Described from a specimen preserved in spirits.

Cabinet of A. J. Skilton, and of the Troy Lyceum of Natural History.

The form of the tail leads to the idea of its being an inhabitant of the water, but I am informed it was found on the land. From *S. granulata* of Holbrook it differs as much in form as in color.

Brought from Oregon by Rev. Geo. Gary, superintendent of missions in Oregon.

Tropidolepis scincicauda, n. s. Slender, tail much longer than the body, cylindrical. Dermal plates of the body and tail, carinate above, smooth beneath, verticillate.

The carinate plates in nine rows.

Color, dusky green above, light ash color below. A row of small dark spots on each flank. Another row of smaller ones along the vertebral line. Some of the dark colored scales on the flanks tipped with a whitish color.

Length five to five and a half inches.

Described as above from a preserved specimen.

Cabinet of A. J. Skilton.

A well marked species. The size of the tail at its origin, from its resemblance to that of the skink, furnishes a strong specific character.

It is gratifying to be able to add another species to the two of this genus, previously known as belonging to North America. The specimens of this species as well as several of the T. undulata, so common in the middle Atlantic states, and also several skinks, resembling S. quinquelineatus, were caught by the Indians for the missionaries, with hair snares. They dreaded them, declaring they were poisonous.

Inhabits the country about the Dalles of the Columbia. Brought as above by Rev. Mr. Gary, superintendent of Methodist Missions.

The artist having to make out the figure by means of the specimens, it *may* be a little longer than the living animal.

Art. XVIII.—*Range of the Gutta Taban Collectors, and present amount of Imports into Singapore.**

In the first number of this Journal, an account of Guttá Tábán appeared, by T. Oxley, Esq., which we are happy to inform our able contributor has been republished in a very great number of periodicals both in India and Europe, and has been acknowledged on all hands to be the best and most complete description of the gutta that has yet been given.† At a later period we gave some details respecting its collection by the Orang Binua in Johore. At that time the principal supply was obtained from Johore, into the jungles of which, parties of Malays and Chinese had penetrated in all directions, while nearly the whole indigenous population were engaged in the search. In consequence of the equivocal position in which government appears to consider it politic to allow the Sultan to remain, the Tamungong has absolute power over the country, and it is to his energetic measures that Singapore has been indebted for a large part of the gutta hitherto imported. Following the usual Malay policy, the Tamungong declared the gutta a government monopoly, so as to secure to himself the greatest share of the profit on the product. The price allowed by him was a fair one, sufficient to induce the Malays to give the collection of gutta a preference to other employments, and to leave them a profit of 100 to 400 per cent. on what they procured from the Binua. The Tamungong himself sent out numerous parties of from ten to one hundred persons, and caused the tribes of hereditary serfs, such as the Orang Sletar, to be entirely employed in searching for gutta. For the same purpose the Sabimba tribe were transported into Johore from the forest of Battam. Subsequently the islands of the Johore Archipelago were laid under contribution, and "menaban"‡ became the cry amongst all their land, river and sea tribes. The Tamungong's collectors even went as far as Linga, and had procured a considerable quantity when the Sultan's eyes were opened to the value of his jungles. He confiscated a part of what had been collected, and following the Tamungong's example, declared gutta taban a royalty. At the period of our visit to the interior of Johore, the Tamungong had made arrangements with the Bindahara to secure the taban of Pahang.

The knowledge of the article has now slowly spread from Singapore in different directions, but we believe has not yet ex-

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The whole of this has been sent to Great Britain, with the exception of 15 piculs to Mauritius, 470·68 to the continent of Europe and 922 to the United States.

About 270,000 taban trees have probably been felled during the 3½ years the trade has existed, and the value of each tree has thus, on an average, been about a dollar.

The price of taban in Singapore gradually rose from eight to twenty-four dollars per picul, but last month it began to fall and is now about thirteen dollars.

In our next, [Jour. Indian Archipelago,] we shall give some more exact details, and notice the mixtures of gutta percha, jelotong, gegrek, litchu and other inferior guttas, the products of different trees, which are sometimes used to adulterate the taban. A large lump was brought to us a few days ago consisting of gutta percha and gegrek, enveloped in a coating of taban about a third of an inch in thickness.

ART. XIX.—*Application of the Galvanic Circuit to an Astronomical Clock and Telegraph Register in determining local differences of longitude, and in astronomical observations generally, in a communication by* SEARS C. WALKER, Assistant U. S. C. S., addressed to Prof. A. D. BACHE, LL.D., Supt. U. S. Coast Survey:—forming a Report to the Treasury Department, by Prof. BACHE, and presented to Congress with a letter by the Secretary of the Treasury.*

I BEG to call your attention to the importance of the use of an electro-magnetic circuit and an astronomical clock in connexion with Morse's telegraph register for the operations of the coast survey, and the general purposes of practical astronomy. Your thoughts having been first turned to the subject of the use of Morse's electro-magnetic telegraph in the longitude operations of the coast survey, in December, 1844, special instructions were issued to me in the autumn of 1845. Under these and subsequent instructions, the operations of 1846, '47 and '48, entrusted to my care, have, until near the close of the latter year, been conducted without the use of the *automatic clock register*.

The importance of the latter instrument induced you to direct the necessary researches to be instituted, for the purpose of introducing it into use in the coast survey service. Several methods have been suggested by eminent mechanicians and electro-magnetists. That of Mr. Wheatstone is briefly alluded to in the proceedings of the Royal Astronomical Society, for Nov. 19th, 1841.

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* Exec. Doc. No. 21, House of Representatives, 30th Congress, 2d Session.

The galvanic circuit in his clock, is made and broken by the use of a circular metallic disk put on to the arbor of the seconds' hand. Alternate intervals of a second, or one sixtieth of the circumference, are made of a non-conducting substance. The disk is insulated and connected with one pole of a galvanic battery. A delicate spring connected with the other pole presses gently on this disk. Thus the circuit is made and broken at alternate seconds. This mode enables the primitive clock to control the motion of any number of clocks in connection with it. Every time the circuit is broken or made, any receiving clock-wheel with sixty teeth may be made to advance one second, and this wheel may in the usual way control the minute and hour wheel.

Mr. Steinheil's galvanic clock is described in Schumacher's astronomical annual, for 1844. The particular machinery for making and breaking the galvanic circuit does not appear to be described; the general object is similar to Mr. Wheatstone's.

I find, as yet, no account of the actual application of these electro-magnetic circuits and astronomical clocks to the purpose of permanently registering the current of time on the running fillet of paper, as used in Morse's electro-magnetic telegraph. It is, however, this latter combination that we must employ in our telegraph operations for longitude. The experience of its advantages for that purpose, induces me, also, to recommend it for the general objects of practical astronomy, as far as relates to the record of minute subdivisions of time, such, for instance, as the determination of absolute or relative right ascensions of the heavenly bodies, or of the local time of their culmination.

The process to be used is dependent on two distinct contrivances. The first is to cause the most delicate astronomical clock to make and break the galvanic circuit at uniform intervals, (say of a second of time,) by an apparatus that cannot possibly injure its machinery or its rate of performance, when connected with the current of the most powerful battery. That of Mr. Wheatstone, and I presume of Mr. Steinheil, accomplishes this purpose effectually.

Professor Bond, without having seen any notice of Wheatstone's invention, had proposed to make the mechanical contact and separation of the pallet and teeth of the escapement wheel, the closing and breaking of the circuit. This method may be readily applied to insulated portions of these parts. It will certainly succeed in practice. It is, however, liable to the danger of deflagration of the metallic surface of contact, and perhaps to that of modifying the arc of vibration, by electric or electro-magnetic repulsion.

Dr. Locke of Cincinnati, to whom I mentioned your wishes on the 25th of October, not having seen a description of Mr.

Wheatstone's electro-magnetic clock, undertook to make a series of experiments on the subject. He succeeded, on the 6th of November, in inventing a method which like the former, is found to be perfectly successful in practice, and free from danger to the machinery and motion of the clock. Instead of a disk, Dr. Locke uses a wheel with sixty teeth, each of which when horizontal strikes against the handle of a platinum tilt hammer, weighing about two grains, and knocks up the hammer, which instantly falls to a state of rest on a bed of platinum. The fulcrum of the tilt hammer and the platinum bed rest severally on a small block of wood. Each is connected with a pole of the galvanic circuit, and the circuit is alternately broken and made by the rising and falling of the hammer. The latter operation takes about one-tenth of a second of time.

I think it is manifest that either method will succeed in practice, which alone can test their relative excellence. To Mr. Wheatstone, however, belongs the merit of priority in effecting the primary object of causing the astronomical clock to make and break the circuit of a galvanic battery, without injury to the machinery or movement of the clock.

Waiving the question of the relative excellence of the two inventions, and leaving it as a subject for special experiments, I come now to the second requisite for the fulfillment of your wishes, viz: the connexion of the astronomical clock with Morse's electro-magnetic telegraph. In this department, so far as I am informed, the first experiment has been made in this country.

An experiment of the combination of an electro-magnetic clock and Morse's telegraph register, was made by Professor Mitchell and myself at the Cincinnati observatory on the 26th of October last, on a plan, however, which I did not consider to be suitable for nice astronomical observations.

On the 17th of November last, Dr. Locke's delicate astronomical clock, of his own construction, was supplied with the requisite apparatus made from his drawings by his son. At the expense of the coast survey, I directed wires to be put up for the purpose of connecting his clock with the Cincinnati and Pittsburg line, about four hundred miles in length. The experiment was eminently successful, and the registering of the seconds of time on the running fillet of paper was continued for two hours at all the offices along the line, much to the astonishment of the operators. I send you a specimen of the graduated fillet of paper. It consists as you will notice, of an indented line of about nine-tenths of an inch in length, followed by a complementary blank space of about one-tenth. The two make a second of time, commencing with the beginning of the line.

This graduated fillet of paper I will call for the present the *automatic clock register*, whether it is furnished by Wheatstone's

or Locke's apparatus for attachment to the arbor of the seconds hand of the primitive clock.

In order to carry out fully your wishes and instructions, it would be necessary that this automatic clock register should distinguish the hours, minutes and seconds. Dr. Locke proposes for this purpose to make the beginning of the ordinary minutes omit *one*, of *fives* of minutes *two*, of *tens* of minutes *three*, and of *an hour* omit *four* consecutive blank spaces. Thus *ordinary* beginnings of minutes have continuous lines of *two* seconds, *fives three*, *tens four*, and *hours five.*

The mode of using the register for marking the date of any event that cannot be determined *automatically*, but whose occurrence must be known from human sensations, is to tap on a *break circuit key* simultaneously with the event. The beginning of the short blank space thus registered in the midst of the indented line of the *automatic clock register*, fixes, by a permanent printed record, the date of the event, or rather the date of the human estimate of the event, as indicated by the tap of the key.

For this mode of distinguishing the hours, minutes and seconds on the fillet of paper, and for the idea of using the break circuit key, I was indebted to Dr. Locke. This kind of key is required by the necessity of having a closed circuit for the *register* as much of the time as possible, so that an event occurring any where along the line may be instantly recorded on the register.

Having thus given credit to Mr. Wheatstone and to Dr. Locke for the parts severally performed by them in the perfection of this process, I beg to suggest the following slight modification of Dr. Locke's mode of marking seconds, whether we use for our automaton Wheatstone's circular disk or Locke's toothed wheel and platinum tilt hammer. I would mark the beginnings of ordinary fives and tens of minutes and hours, as Dr. Locke does. I would make the blank spaces of the other ordinary seconds the smallest possible consistent with the certainty of breaking circuit. The blank spaces of the *fives* of seconds should be visibly larger, those of *tens* still larger, finally those of *thirties*, largest of all.

By this arrangement the eye would readily distinguish the exact value of the numbers of whole seconds. An inch of paper is, I think, enough for a second of time. The probable error of the reading of the fractions of a second with a proportional scale or compass, will not be greater than one hundredth of a second. I would have the register adjusted by a centrifugal clock like those of the Munich equatorials, so as to deliver, as near as may be, one hundred inches of paper in one hundred seconds of time of the *automaton clock register*.

Instead of a proportional compass we may use a graduated scale of some translucent substance laid on the printed register. For the sake of uniformity of hygrometric expansion, a graduated scale made of a portion of the registering fillet will perhaps be preferable. A small correction may in this case be applied if necessary, for the rate of the automatic clock on an assumed scale of paper of a second to an inch. A relative rate of two seconds per minute (an improbable occurrence) will on the average cause only an error of one hundredth of a second in reading off by the scale.

All that I have now proposed may be accomplished by the first disk or toothed wheel and tilt hammer.

Dr. Locke's mode of distinguishing the subdivisions of minutes appears to be satisfactory. I see no reason why it may not be effected by a toothed wheel on the arbor of the minute-hand, and another on that of the hour-hand. I mention this for the sake of simplicity, leaving to the mechanician his choice of the mode of effecting the purpose.

In printing on this *automatic clock register*, the dates of such events as a series of bisections of a star by the successive wires of a transit instrument placed at equatorial intervals of two seconds or more, short blank spaces may be made by dwelling for a very small time with the finger on the *break circuit key*.

Isolated events, like the phases of an eclipse or of an occultation, may be distinguished by dwelling with the finger on the key for a space of time longer than the maximum of blank space used in distinguishing the thirty seconds.

In this way we cannot fail of imprinting the date of an event. If the signal break circuit tap occurs in the midst of one of the small blanks, this precaution will secure the record, with an average liability to error for such rare instances, of only one-fourth of the actual blank space of the *automatic clock register*.

Washington City, Dec. 15, 1848.

Having, in the first part of this special report, given a brief history of the steps that led to the invention of the automatic telegraph clock, and of its application to Morse's electro-magnetic telegraph. I beg to offer you such suggestions as have occurred to me in relation to the practical application of it to the longitude operations of the coast survey, and to the general purposes of practical astronomy, on which the survey is dependent for the accuracy of its work.

The great importance of an automatic telegraph clock has often been the subject of conversation between us, but your chief efforts were, necessarily, directed at first to the means of procuring it. A hasty glance at the advantages that would result from the certain possession of such an instrument was made by Dr.

Locke and myself, on the evening of the 17th of November, while watching its performance for a term of two hours or more. Having reflected much since, and consulted with my friends both in and out of the coast survey, I am more and more convinced that it is difficult to form an over estimate of its importance in every department of practical astronomy that involves the nice determination of absolute dates, or of their relative intervals in time. Throughout the whole range of practical astronomy, epochs of time and their relative intervals have been hitherto measured by astronomers by listening to the beats of a clock or chronometer, and estimating the fraction of a second between them when any event has occurred, such as a phase of an eclipse, an occultation of a star, or a bisection of a star, comet, or planet's centre or limb, by the wires of a transit instrument. This use of the ear has been a matter of necessity, not of choice. It is, in every respect, in the subdivisions of time and space, a very imperfect organ. While the eye readily estimates the proportional parts of a line with the precision of a tenth, the ear seldom distinguishes smaller portions of an interval of time than a fifth.

In the case of observing transits of a star with a seconds clock, when greater precision than the estimate of a fifth of a second is required, it is only obtained by long practice and experience, and by the use of an *ocular* estimate of portions of space where the star *was* at the time of bisection, and where it was *seen* to be at the time when the two beats immediately preceding and following this bisection were *heard*.

In order to increase the precision of the comparison of two sounds together, in point of time, it is necessary gradually to diminish their interval asunder until the *minimum audible* of about a hundredth of a second is attained. This advantage attends the comparison of chronometers by coincidence of beats, when one has a more rapid movement than the other; but it cannot be brought to bear upon the association of the time of a visible bisection of a star with the date of the hearing of the beats of a clock. The average uncertainty of such an association, as appears from my last report of the result of four thousand experiments on this subject, among the officers of the coast survey, is seventeen hundredths of a second. Of this sum, the greater portion is probably due to the imperfection of the ear as an organ, in associating its sensations with those of sight. I do not speak now from actual experiment, as I hope to do another year. It is well known, however, that the nerves and sensations of sight and touch are far more intimately connected together than those of the eye and ear.

I have repeatedly noticed the advantage of the substitution of the sense of touch for that of hearing in the use of *chronographs* for making a visible register of the dates of bisection of transit

wires by a star. I have known persons afflicted with deafness, and, from that circumstance, compelled to resort to the use of chronographs, to make more precise observations than those of persons in other respects similarly situated; but who, having good sight and hearing, estimated fractions of a second by means of the use of the eye and ear. I think we may assume, subject, however, to correction by actual experiment, that the precision of the combinations of sight and touch is to that of sight and hearing nearly as seventeen to ten.

This estimate supposes that no error is committed in the mechanical operation of imprinting and reading off.

Now, this certainty is furnished for the first time in the history of the science by the use of the automatic telegraph clock. The objection to the use of chronographs in an observatory has arisen from the uncertainty of their rates, and from the necessity of immediately transcribing and obliterating the record made on them for the purpose of identifying it, and preparing the dial for a fresh record. Both of these objections are removed by the use of the *automatic clock register*.

The rate of this register has all the precision known to astronomers. The length of a continuous fillet is limited only by the size of the paper reels that may be considered convenient for use. An eight-day clock might be made to deliver a continuous graduated register from one winding to another.

A single label on any part of it, to identify one of the seconds, fixes them all.

I have before remarked that the error in the mechanical part of imprinting a date on the *automatic clock register*, and in reading off, need not exceed a hundredth part of a second. It may, in fact, be reduced to a ten-thousandth part of a second by substituting for the paper fillet a metallic cylinder revolving like a barrel organ, and graduating the seconds on a spiral line. Perhaps Mr. Bains's method of registering on a paper, in a spiral line, may supersede Mr. Morse's running fillet.

The great advantage of the method of imprinting the dates of bisections of a star, by the wires of a transit instrument, does not depend merely on the increase of the precision of a single result.

The facility of acquiring the practical skill necessary for tapping on a key, at the date of a visible bisection, is very great. A few hours in this respect take the place of months, if not of years, spent in learning to associate together the sensations of sight and hearing, so as to make a good transit observation.

The third and paramount advantage of the method of imprinting the dates of bisections of wires by a star, is in the *sevenfold* accumulation of results in a single culmination, or in a given period of time.

Fifteen seconds is the ordinary equatorial interval for the wires of a transit instrument, and we have the authority of the greatest of practical astronomers, the lamented Bessel, that five wires, with this interval, are better than seven wires compressed into the same space.

By using the method of imprinting the dates of the bisections of these wires, on the *automatic clock register*, where the use of the ear, and the counting of beats, and the manual labor of writing down these dates, are all dispensed with, the equatorial intervals may be reduced from fifteen to two seconds, or even to one and a half.

In this manner the number of bisections in a single culmination of a star may be multiplied *sevenfold*, as I have already mentioned.

The advantage of the method of imprinting dates of bisections of wires by a star on the *automatic clock register*, from those three separate sources of gain, may in round numbers, be estimated at *tenfold*.

The remarks that follow are based on such an estimate, and are consequently subject to a proportional modification, when the true numerical ratio shall have been determined by experiment. According to this estimate then, we are authorized to conclude, THAT THE VALUE OF A NIGHT'S WORK WITH A TRANSIT INSTRUMENT, BY THE PRINTING METHOD, IS ABOUT TEN TIMES AS GREAT AS BY THE METHOD NOW IN USE AMONG ASTRONOMERS.

For moon culminations, which depend upon the comparisons of transits of the same heavenly bodies, here and in Europe, *fifty* wires may take the place of *seven*, and one *month's* work may take the place of a year's work in the manner hitherto performed.

For catalogues of stars, such as were formerly made in Paris and Konigsburg, and are now made at Munich, Bonn, and Washington, where a transit over one wire only, is usually observed in a night, *seven* transits may now take the place of *one*, and from the superior facility which the printing method gives of adjusting the transit instrument, the subject of the right ascension of the stars of such catalogues may now be exhausted for the epoch of the observation.

In the case of the *ten year* catalogues of the right ascension of stars, from the royal observatory at Greenwich, the same labor spent by the astronomer at the transit instrument, by the use of the printing method, may furnish one of equal precision *every year*.

I am bound to make an exception in favor of the catalogues of stars furnished by Mr. Rumker from the Hamburg Observatory. This indefatigable astronomer, by some process apparently unknown to his professional brethren, has already doubled the ordinary number of bisections of a star at a single culmination.

In his catalogues of right ascensions of stars the use of the printing method would only introduce a *fivefold* instead of a *tenfold* gain.

I venture to suggest that our National Expedition to Chili, under Lieutenant Gilliss, will by the use of the printing method, furnish nearly *ten* times the precision in the value of the parallax of Mars, from his relative transits with the same star, both east and west of the meridian, that would result from the ordinary method of observation.

There is, however, no one branch of practical astronomy, or coast survey operations, where the benefit of the *automatic clock register* will be so great as in the determinations of relative longitude of the stations.

One night's work with the printing method will be worth as much as any single campaign has been heretofore between any two stations.

The importance of this branch of the duties of the coast survey induces me to dwell more at length on the subject. Your operations propose, for the first time in the history of geodesy, to measure astronomically a long arc of a parallel with a precision commensurate with the former and present astronomical measures of arcs of the meridian.

I would, for this purpose, respectfully recommend the mounting of one of Mr. Wheatstone's, or of Dr. Locke's, clocks at some central astronomical station, having easy telegraph communication with the northern and southern points of the coast survey. This central station, and any other one or more stations intended to be compared together, may be supplied with transit instruments, constructed with special reference to the advantages of the printing method. I would respectfully recommend the use of a transit instrument with a frame of a cast iron box, and with three or more doubled faced levels on each side suited to both zenith and nadir pointings. When not too cumbersome, as in the case of the coast survey instruments, I would wish for an azimuth adjustment, with graduated micrometer head, like the Simms transit instruments now in use in the coast survey. I would wish to retain the principle of rapid reversals, and would extend it to zenith stars. The inner portion of the pivots may rest on counterpoises with friction rollers. I would wish the reversing apparatus to have the following advantages, leaving to the mechanician the decision as to the mode of securing them. The time occupied in the reversal and in repointing the instrument, by making it revolve on its axis through the double of its zenith distance before reversal, should not exceed twenty seconds. The pointing may be done by means of an adjustable clamp, suited to the declination of the star. The pivots need not be elevated more than half an inch in order to move free of the

sockets. Two turns of a screw might elevate; one turn more reverse it, and two more turns place it at rest on the socket and friction rollers.

The net work of the transit instrument may consist of groups of five wires, each separated by an interval of once and a half the ordinary space.

For the sake of rapid observation of circumpolar stars, the inner group may have half the ordinary interval. In the case of equatorial stars, only three of these wires need be used. The equatorial intervals may be one for the inner. and two seconds for the other groups. The intervals between the groups may be three seconds. My micrometric measures, with the great Fraunhofer equatorials, show that fifteen-hundredths is an ordinary, and two-tenths of a second of time an extreme value of the subtense of a spider line for a four foot tube. The smallest clear intervals between the wires would be *four*, the ordinary *nine*, and the greatest *fourteen*, diameters of the opake wires.

The number of these tallies may be seven, nine, or eleven, according to the focal length of the telescope, and the mechanical facility of graduating the diaphragm and of setting the spider lines. Since the register is permanent, and may remain for reference, it is only necessary to enter in the written journal the mean for each tally from the mean of the five readings. To prevent the accumulation of these registers from filling too much space, the same fillet of paper may have several parallel lines of the *automatic clock registers* imprinted on it, by means of a micrometer motion of the graver.

Where the observatory is fixed, and the line short, and the Grove's cups are charged anew with acid every day, the registering fillet may contain one or two months' continuous record on one reel. All the transits observed in the occupancy of a single temporary station may be preserved on one reel. In order to identify dates, and particularize records. the observer keeps a memorandum book in which he records the level readings, and refers to each celestial object by a letter or number, with accents or side numbers denoting the order of the lines on the fillet.

A duplicate mark is made on the fillet itself. A receiving reel of dimensions similar to the delivering one, affords a compact disposition of the printed register. A tell-tale check connected with it will enable the transcribing clerk to turn at once to any date on the paper, without examining the intermediate spaces.

In using these instruments for longitude operations, zenith stars are selected at the eastern station. The declination clamp is adjusted ready for reversals.

The levels are all read. Twenty dates of bisections in the first position of the instrument are imprinted, the reversal and re-pointing is effected, twenty more bisections by the same wires in a

reversed position of the instrument are imprinted, the levels are again read, and the registering fillet labeled. The same operation is repeated on the same star at the western station. The electro-magnetic clock may be rated at the central station. The *automatic register* may be kept there, and the printed record may be there preserved. Check registers may be kept at the other stations. The imprinted culminations of two fundamental stars at the same station, whether eastern, or western, or central, will serve to fix the rate of the primitive clock. The reversals remove the error of collimation, and furnish, by taking the means of the printed dates for each wire, twenty normal bisections with reference to the optical axis of the telescope. On applying the corrections for the levels, we have twelve normal level readings with reference to the zenith and consequent meridional point near the position of actual observation. The facility of observing transits of circumpolar stars, gives extraordinary precision to the azimuth correction, which moreover nearly vanishes with circumzenith stars.

A consideration of these numerous advantages of the printing method for longitude of stations, leads me to believe that one single culmination of a circumzenith star at each of the two stations thus observed, may give their relative longitudes to a few hundredths of a second, which is all that can be said of our present knowledge of those of the Greenwich and Paris observatories, the two oldest in the world. The check readings of the levels with nadir pointings adds to the certainty of the work. If the concluded difference of longitudes of the zenith and nadir portions of the meridians conform, our confidence in the result is much strengthened.

If the discrepancy is sensible, the mean of the results may serve to eliminate any want of symmetry in the pivots or sockets, or any irregular action of gravity or sudden change of temperature on the parts of the instrument.

In the above process all sources of error in the result are eliminated except the difference of the *break circuit armature* times, and personal equations of the astronomers in tapping on the key. The rule adopted in good telegraphic offices, and which must be inflexibly adhered to in all astronomical operations, of adjusting the *outer* and *inner* limits of *armature distance* to a *minimum* value, secures us against error from the first source. When the total quantities are so small as to be insensible to the ear, their difference, which is a term of the second order, must necessarily be evanescent.

The personal equations of tapping on the key for the instant of a bisection are much smaller than those which arise from the combination of sight and hearing.

They are also more uniform and less dependent upon the nervous temperament of the individuals. They may be determined in a few minutes' time by the astronomers, on meeting at the same station, by striking alternate wires, each party being alternately a leader. A few pairs of culminations printed in this way fix the value of the equation if any exist.

These views, which I have felt it my duty to lay before you at length, are the result of a separate trial of each of the processes involved in the art of imprinting dates. The experience of the last summer furnishes some six hundred cases of imprinting dates on an ungraduated fillet of paper. Dr. Locke's electro-magnetic clock, on the 17th of November, furnished an ample trial of the method of *graduating* the paper.

The combination of the two operations so as to imprint the dates of culminations on the *automatic clock register*, would have been tried that night, but for the failure of the line from Pittsburg to Philadelphia. The full trial, however, of the combination in all its perfection, requires the construction of the proper instruments; with them, under your instructions, I hope, at an early date, to submit these opinions to the test of practical experiment.

Permit me to say a word on the experience of the Coast Survey in regard to the length of telegraph lines. This year we made abundant experiments on the line from Philadelphia to Louisville, a distance in the *air* of *nine* hundred miles, and in circuit of *eighteen* hundred miles. The performance of this long line was better than that of any of the shorter lines has hitherto been.

Not more than two or three good astronomical nights, at Cincinnati and Philadelphia, were lost by failure of any part of the line, in the periods of nearly two months of our stay at Cincinnati. I learn from an authentic source that the same success attends the work from Philadelphia to St. Louis, A DISTANCE IN CIRCUIT OF ONE-TWELFTH OF THE EARTH'S CIRCUMFERENCE.

The number of Grove's pint cups used is about one for every twenty miles. It is natural to conclude from this experiment, that if a telegraph line round the earth were practicable, *twelve hundred* Grove's pint cups, in equi-distant groups of fifties, would suffice for the galvanic power for the whole line.

The daily expense of acids for maintaining this motive power, would be about five mills per day for each cup, or six dollars per day for the whole line.

Washington, December 15, 1848.

ART. XX.—*Parallelism of the Palæozoic Formations of North America, with those of Europe;* by ED. DE VERNEUIL, translated, with annotations by JAMES HALL.

(Continued from p. 51.)

M. DE VERNEUIL, in the conclusion of his paper on the parallelism of the European and American formations, offers some general remarks upon the species of fossils common to the two countries, showing by a table of the successive groups the geological range of the species. The first part of this we have translated entire, while in the remainder we have noticed only these species concerning which there exists some difference of opinion.

We give in the following Table, the list of species common to Europe and North America. This list is made from our own observations, that is to say, we have seen in collections or in the rocks the species which are here enumerated. We have placed opposite to each species columns corresponding to the thirty-one groups of which the palæozoic formation in the United States is composed, and we have indicated by asterisks those of the groups where they are found. We can thus, by a simple inspection of the table, easily understand the different duration of the species, and distinguish those which traverse many systems from those which are limited to a single one. We can, moreover, which is also essential, follow the succession of these last in the different stages which compose that which is called a system. It will be perceived that the species have very seldom lived throughout the entire duration of the system of which they are said to be characteristic; that they have set out from different levels, and that between the first and last beds, differences thence result, which appear to prepare for the establishment of the succeeding system.

The table contains one hundred and seventeen species, or about one-fifth of all those which we have seen during our journey. The four-fifths of the fossil species of the palæozoic series of North America appear, then, to be peculiar to this continent,* and thus prove to us that from the earliest times of creation, animals observed, in their geographical distribution, laws more or less analogous to those which govern them at the present day.

* This is very nearly the proportion which we have already indicated in our work upon Russia. (Geologie de la Russie d'Europe et de l'Oural, vol. ii. p. 31.)

[In the first volume of the Palæontology of New York, embracing descriptions of three hundred and eighty species of lower Silurian age, not more than one-twentieth part can be regarded as identical with species heretofore described in Europe. This number includes, however, some species known to occur in Europe, but which have never been described, though it is not probable that the proportion of species of this period common to the two continents will ever be found as great as the proportion given by M. de Verneuil. In the upper Silurian and Devonian periods, the proportion of species common to the two continents is probably greater than in the lower stages.—J. H.]

TABLE

Of the species common to Europe and North America and of the subdivision of the palæozoic formation in which they occur.

	Lower Silurian.						Upper Silurian.							Devonian.								Lower Carbn'f.		
	1. Potsdam sandstone.	2. Calciferous sandrock.	3. Black River limestone.	4. Trenton limestone.	5. Utica slate.	6. Hudson River group.	7. Gray sandstone.	8. Oneida grit.	9. Medina sandstone.	10. Clinton group.	11. Niagara group.	12. Onondaga salt group.	13. Water-lime group.	14. Pentamerus limest.	15. Delthyris shale.	16. Upper Pentam. limest	17. Oriskany sandstone.	18. Cauda-galli grit.	19. Scoharie sandstone.	20. Onondaga limestone.	21 Corniferous limestone.	22. Marcellus shale.	23. Hamilton group.	24. Tully limestone.	25. Genesee slate.	26. Portage group.	27. Chemung group.	28. Old red sandstone.	29. Micaceous sandst.	30. Carbonifer's limest.	31. Carbonif. formation.
Holoptychus nobilissimus.																												*		
Teeth of Dendrodus.																												*		
Asterolepis ?																												*		
Calymene Blumenbachii.																			*				*							
" var. senaria.										*	*								*											
" Fischeri.				*																										
" punctata.				*																										
Illænus crassicauda.				*						*																				
Lichas laciniata.			*	*																										
Ceraurus pleurex'mus.				*																										
Trinucleus concentri.				*																										
Phacops Hausmanni.				*		*																								
" Dalmani.														*	*															
" limulurus.				*																										
" macrophthalmus.											*																			
Cryphæus calliteles.															?				*	*	*		*							
Bumastus barriensis.																							*							
Homalonotus delphin's.						*					*																			
Cheirurus insignis.											*																			
Sphæroëxochus mirus.											*																			
Agnostus latus.										*																				
Phillipsia semimfera.										*																				
Orthoceratites communis.																													*	*
" annulatus.			*	*																										
" calamus.											*																			
Lituites convolvans.																													*	*
Gomatites rotatorius.			*																											
" retrorsus.																														
Nautilus tuberculatus.																														
Bellerophon bilobus.																														
" striatus.																														
" Urii.																														
" bilobatus.																														
" dilatatus.				*																										
Pleurotomaria lenticularis													*																	
Subulites elongata.				*																										
Euomphalus carbonarius.				*																										
" pentangulatus																														*
Macrocheilus curvilineus.																														*
Chemnitzia nexilis.																														
Murchisonia bilineata.																														
Avicula damnoniensis.																														
Pterinea fasciculata.																														
Modiola squamifera.																														
Isocrania cincinnatiensis.																														
Cardium lorientata.																														
Lucina proava.																														
" tegens																														
Cranaysia lamellicostata.																														
Sanguinolaria dorsata.																														
Allorisma sulcata.																														
Terebratula cuboides.																														
" deltoa.																														
" equata.																														
" marginalis.																														
" reticularis.																														
" aspera.																														
" hemisphærica.																														
" concentrica.																														
" tumida.																														

TABLE

Of the species common to Europe and North America and of the subdivision of the palæozoic formation in which they occur.

	Lower Silurian.						Upper Silurian.									Devonian.											Lower Carb'n'f		
	1. Potsdam sandstone.	2. Calciferous sandrock.	3. Black River limestone.	4. Trenton limestone.	5. Utica slate.	6. Hudson River group.	7. Gray sandstone.	8. Oneida grit.	9. Medina sandstone.	10. Clinton group.	11. Niagara group.	12. Onondaga salt group.	13. Water-lime group.	14. Pentamerus limest.	15. Delthyris shale.	16. Upper Pentam. limest.	17. Oriskany sandstone.	18. Cauda-galli grit.	19. Scoharie sandstone.	20. Onondaga limestone.	21. Corniferous limestone.	22. Marcellus shale.	23. Hamilton group.	24. Tully limestone.	25. Genesee slate.	26. Portage group.	27. Chemung group.	28. Old red sandstone.	29. Micaceous sandst.	30. Carbonifer's. limest	31. Carbonif. formation.
Terebratula Wilsoni.	.	.	.	.	.	.	.	.	.	.	*																			
" Roissyi.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*		
" planosulcata.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*
Pentamerus oblongus.	.	.	.	.	.	.	.	.	.	*																				
" galeatus.	.	.	.	.	.	.	.	.	.	.	.	.	*																	
Spirifer cyrtæna.	.	.	.	.	.	.	.	.	.	*																				
" sulcatus.	.	.	.	.	.	.	.	.	.	*																				
" crispus.	.	.	.	.	.	.	.	.	.	*																				
" bilobus.	.	.	.	.	.	.	.	.	.	*	.	.	.	*																
" mucronatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	*	.	.	.	*			
" macropterus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*													
" cultrijugatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	*	.	*								
" heteroclitus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	*								
" Verneuili.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*			
" lineatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*
" striatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	*	
" attenuatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	*	*
" cuspidatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	*	
" lynx.	.	.	.	*	.	*	.	.	.	*																				
Orthis testudinaria.	.	.	.	*	.	*																								
" elegantula.	.	.	.	.	.	.	.	.	.	.	*																			
" hybrida.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	*															
" striatula.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*					
" Verneuili.	.	.	.	■																										
" umbonata.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*						
" crenistria.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	*	*	*
" resupinata.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	
" Michelini.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	*
Leptæna depressa.	.	.	.	*	?	.	.	.	.	*	*	.	.	.	*	.	.	.	.	*	*	.	.	.	.	.	.	*		
" subplana.	.	.	.	.	.	.	.	.	.	*																				
" transversalis.	.	.	.	.	.	.	.	.	.	*																				
" Dutertrii.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*						
" laticosta.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*						
Chonetes nana.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*								
" sarcinulata.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*
Productus subaculeatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	*	*	.	.	.	*			
" semireticulatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	*	*
" cora.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	*	*
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" punctatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	*	*
" costatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	
Hypanthocrynites decorus	.	.	.	.	.	.	.	.	.	*																				
Cidarites Nereï ?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	*	
Favosites gotlandica.	.	.	.	.	.	.	.	.	.	.	*	.	*	.	.	.	.	.	.	*										
Fungia gotlandica.	.	.	.	.	.	.	.	.	.	*																				
Porites interstincta.	.	.	.	.	.	.	.	.	.	.	*																			
Catenipora escharoides.	.	.	.	.	.	.	.	.	.	*	*	.	.	.	.	.	.	.	.	*	?									
Stromatopora concentrica.	.	.	.	*	?	.	.	.	.	*	*	.	.	.	.	.	.	.	.	*										
Amplexus spinosus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*		
Cyathophyllum nitratum.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*		
Chaetetes petropolitanus.	.	.	.	*																										
" capillaris.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	
Fusulina cylindrica.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*
Cornulites serpularius.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
Pleurotyctium problem'm.	.	.	.	.	.	.	.	.	.	*																				
Tentaculites ornatus.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*									
Graptolites sagittarius.	.	.	.	.	.	.	.	.	.	.	.	.	*																	
Phthonia lanceolata.	.	.	.	.	*	*																								
Total.	0	0	3	18	1	6	0	0	0	12	27	0	2	3	7	0	2	0	4	6	16	1	18	2	0	2	8	2	14	16	16

Remarks upon the Palæozoic Fossils common to America and Europe, and upon the relations which they offer in their distribution.

Holoptychus nobilissimus, (Agass.)—This fish, characteristic of the old red sandstone of Scotland, England, and Russia, is found at Blossburgh, in Pennsylvania, in the thick stage of the sandstone which forms the superior part of the Devonian system.

Dendrodus, (Owen.)—We think we are able to refer to this species the tooth figured by Mr. Hall in his final Report on the Geology of New York, (page 281, fig. 4,) and found at Blossburgh with the preceding species. The genus *Dendrodus* is characteristic of the old red sandstone of Scotland, and the Devonian beds of Russia.

Asterolepis, (Eichw.)—We refer to this genus two fragments of American fishes; one which we have seen in the collection of Mr. Gebhard,* and which he told us had been found in the calcareous sandstone of Schoharie, and the other which we purchased, and which appears to have come from the Hamilton slates. This last presents no points of difference from the specimen which I found in the Eifel.

Calymene Blumenbachii, Brong.; *C. senaria*, Conrad.—Mr. Conrad has given the name of *C. senaria* to a variety of *C. Blumenbachii* which is found in the most ancient palæozoic beds, (the Trenton limestone and the blue limestone of Ohio,) which is distinguishable from the species of M. Brongniart only by the contraction of the front part of the middle lobe of the head; a character which allies it, in some degree, with the *C. Tristani*. The true *C. Blumenbachii* unquestionably exists in America in the upper Silurian system, (*Clinton* and *Niagara groups*.) Its var. *major* figured by Murchison, (Silurian system, plate 7, fig. 6,) and named by Mr. Green *C. platys*, would be found according to this author in the calcareous sandstone of Schoharie. If this is so, this variety which belongs in England to the Ludlow stage, must have lived in America in beds which we consider a little more recent.†

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* The collection of Mr. John Gebhard, Jr., is one of the richest for the series of rocks and fossils which constitute the hills of the Helderberg around Schoharie, and its owner does himself pleasure in making it accessible for the inspection of strangers.

† [It appears to us that the *C. senaria* is distinct from *C. Blumenbachii* of Dudley. The Niagara species, which is similar in character, possesses features somewhat more like the Dudley specimens. The *Calymene platys* of Green, which occurs in the Schoharie grit, is always much larger than either of the preceding, and possesses other characters which seem sufficient to distinguish it as a species. Regarding for a moment this species as identical with the older forms, we have the *C. Blumenbachii* appearing in the lower Silurian strata very abundantly, and reappearing in the Niagara group, while during the subsequent deposits of water-lime,

C. Fischeri, Eichw.—This species, characteristic of the lower Silurian limestones of Russia and Sweden, is found at Knoxville, in Tennessee, at the base of the palæozoic series. Prof. Troost has a beautiful specimen of it. It is recognized by the twenty-three articulations of which it is composed. We think we might unite with it the *Amphion pseudo-articulatus* of Portlock, of the lower Silurian stage of Ireland.

B. punctata, Brünn., sp.; (*C. variolaris*, Brongn., not Murch.)—This species has been found by Mr. Hall at Middleville, in the Trenton limestone, and by Mr. Norwood at Madison, Ia., in the lower layers of the cliff limestone, which correspond to the Clinton group. We have seen it also at Springfield, Ohio, with the *Pentamerus oblongus*, in the magnesian limestones, which are undoubtedly parallel to the Clinton group. In England the *C. punctata* is found both in the sandstones of Caradoc, and in the schistose slates of Wenlock. In these same slates it is found in the island of Gothland. In the islands of Dago and of Œsel, as well as in those of Christiania, the *C. punctata* appears to be found near the line of junction of the superior and inferior stages of the Silurian system.*

Illænus crassicauda, Wahl. sp. (*Bumastis trentonensis?* Emmons.)—We have seen only detached parts of this species, and principally the post abdomen or pygidium. It belongs to the most ancient beds. We recognize it upon the Black River, and in the vicinity of Trenton, New York, in Pennsylvania, and at Knoxville, Tennessee, where it is associated with the *C. Fischeri*. This species occupies the same position in Europe, and belongs exclusively to the inferior stage of the Silurian system in England, in France, in Sweden, and in Russia.†

Lichas laciniata, Wahl., or perhaps *Lichas scabra*, Beyrich.—It is very difficult to say to which of these two species we should refer the beautiful specimen found by Mr. Carly in the blue limestones of Cincinnati.

Pentamerus limestone and Delthyris shaly limestone, in which we know some eight or ten species of trilobites, this one never appears; and yet after the deposition of the Oriskany sandstone and Cauda-galli grit, we find it flourishing in considerable numbers and of increased size. Its non-appearance during the intermediate period seems an argument against the identity of the species in the two positions, aside from other characters by which we regard it as positively distinct. —J. H.]

* [I do not regard it as well ascertained that the species from the Trenton limestone and the Clinton group of New York are identical. The species from the Trenton limestone is given under the genus Ceraurus, in the first volume of the Palæontology of New York. It is not a true Calymene, having the facial structure like Phacops, with eyes differing from either genus. I have shown some slight differences between our species and that of the Wenlock formation of England: and there are other and more important differences between the one already described and that in the Clinton group.—J. H.]

† [The Bumastis trentonensis of *Emmons*, Illænus trentonensis, Pal. N. Y., vol. i, p. 230. pl. 69, fig. 5, appears to be quite distinct from *I. crassicauda*, and is an extremely rare species, while the latter is of frequent occurrence.—J. H.]

The *Lichas scabra* of Bohemia belongs, according to Mr. Barrande, to the lowest beds of the upper stage of the Silurian system, while the *Lichas laciniata* of Sweden, is found, like that of America, in the lower stage. We have seen in the collections of Mr. J. Hall, at Albany, a specimen very much like that of Cincinnati, coming from the Trenton limestone.

Ceraurus pleurexanthemus, Green.—In comparing the fragments of the head which I possess, of this species with the *Cheirurus exsul*, Beyrich, I have not been able to discover any difference. This author, like ourselves, knew only of the head of the *Cheirurus exsul*, which has been found in the bowlders of limestone coming from Scandinavia, and containing the most characteristic trilobites of the lower stage of the Silurian system, such as the *Asaphus expansus* and *Illænus crassicauda*. The *Amphion gelasinosus*, Portlock, of which this author has seen only the head, and which appears also to be the same species, belongs to the lower Silurian beds of Ireland. The *Ceraurus pleurexanthemus* characterizes also the same stage in America. We have found it at Middleville, N. Y., in the Trenton limestone, and at Galena, Illinois, in the blue limestone. Mr. D. Dale Owen says he has found it at Cincinnati in beds of the same age.*

Trinucleus caractaci, Murch.—This species is abundant in America, chiefly in the Hudson River group of the State of New York. It occurs also in the blue limestone of Cincinnati, and of Newport, in Kentucky. According to Prof. Emmons, the *T. tessellatus*, Green, very abundant in the lower beds, that is to say, in the Trenton limestone at Sackets Harbor, at Glens Falls, N. Y., and at Montreal, is distinguished from the *T. caractaci* by the shorter spiniform prolongations, by the narrower perforated limb, and by the number of perfect circles of perforations which would be three instead of four.† The *T. caractaci* belongs in Europe to the middle and upper region of the lower Silurian stage, and is found principally in the sandstone of Caradoc. All the species of Trinucleus are in general proper to the lower stage of the Silurian system. We know no exception to this rule in America, and we know only one in Europe.‡

Phacops Hausmanni, Brongn., sp.—This species, in Bohemia, proper to the higher and middle divisions, appears in America in exactly the same position, that is to say, in the Pentamerus gale-

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* [This peculiar and well marked species is evidently identical with the *Cheirurus exsul* and *Amphion gelasinosus* cited above, and also with *Calymene? speciosus*, Dalman. It is also closely allied, or identical with several other European species which have been described from fragments. (See Pal. N. Y., vol. i, p. 242.)—J. H.]

† Mr. Hall thinks, nevertheless, that the *T. tessellatus* and *T. caractari* should be united. [See Pal. N. Y., vol. i, p. 249.]

‡ It is said that Trinucleus has lately been found in the slates of Wenlock.

atus limestone, and in the Delthyris shales of the State of New York. It has been described by Mr. Green under the name of *Asaphus micrurus*. According to Mr. Troost, (sixth Report,) it exists also in Tennessee. [The *Asaphus pleuroptyx*, Green, is also identical with *P. Hausmanni*.—J. H.]

P. Dalmani, Portlock.—Discovered by Mr. Portlock in the lower Silurian stage of Ireland, this species occurs in the same horizon in the Trenton limestone of New York.* Closely allied to the *P. Downingiæ*, it is distinguished by its glabella being more triangular and greatly contracted near the base.

P. limulurus, Green.—The only difference between this species and the *P. mucronatus*, Brongn., or *P. longicaudatus*, Murch., consists in the form of the tail, which is shorter with a wider base. If this difference, observed in a greater number of specimens than we have been able to see, obliges us to maintain the specific separation of *P. limulurus*, perhaps it might be considered as intermediate between the *P. mucronatus* and *P. caudatus*. There is besides, with these two species a great similarity of position. It is found in the schistose slates of Niagara, as the two preceding species are in the slates of Wenlock. The *P. mucronatus*, nevertheless, in Brittany, descends as far as the lower Silurian schists, while the *P. caudatus* remains limited to the Wenlock group, the same as the *P. limulurus* to the Niagara.

We have found also in the west of the United States the pygidium separated, too incomplete to be referred with certainty either to the *P. limulurus* or *P. caudatus*. These specimens are not rare in the cliff limestone of Ohio and Indiana, which corresponds to the Niagara group. One of these incomplete pygidia belonging perhaps to the *P. limulurus* was given to us at Dayton, Ohio, by Mr. Vancleve, as coming from a yellow limestone which appears to be intermediate between the two great Silurian stages.

P. macropthalmus, Brongn.; (*Calymene bufo*, Green; *Asaphus megalopthalmus*, Troost; *C. latifrons*, Bronn.)—This species in America as in Europe, is one of the most widely spread, principally in the Devonian system. We do not know it personally lower: nevertheless we have seen specimens of it coming from Gaspe (New Brunswick), a locality which to judge from other fossils, appears to be upper Silurian, and Mr. Conrad has cited it also in the Delthyris shales, (No. 15.) Nothing is more common, on the contrary, than this trilobite in the Devonian system as we limit it. It occupies principally the lower parts from the Schoharie grit to the Hamilton group. In the state of New York it is at the deposition of the extensive shales of the Hamil-

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* [This species is described as P. *callicephala* in the Palæontology of N. Y., vol. i, p. 217.—J. H.]

ton group, that it takes its greatest development, while in the states of Ohio and Indiana where these shales are wanting, it is found abundantly in the limestones which form the upper part of the cliff limestone.

Localities.—Lewis' creek, Charlestown Landing (Indiana); Cacapou, near Hancock (Va.); Gaspe (Canada); Schoharie, Moscow, (New York.) In Europe as in America, the *P. macropthalmus* is rare in the Silurian system, while it is very abundant in the Devonian beds of the Eifel. In Russia it is found only in the Devonian system of the Altai.*

Cryphæus callitcles, Green.—This species is so similar to the *Phacops stellifer*, Burm., that it would, perhaps, be proper to unite them, and at all events, it is impossible to leave them in two distinct genera. If we retain the genus *Cryphæus*, we should place in it that small division of *Phacops* having long spines on the tail, and which comprises only two species, *P. arachnoides* and *P. stellifer*.

The *C. calliteles* is proper to the Hamilton group, and has been collected by Mr. Marie Rouault in Brittany in the limestones and shales of Gahard which are its equivalent. The *P. arachnoides* and *stellifer* are equally peculiar to the Devonian system of the Eifel.

Bumastis barriensis, Murch.—Characteristic of the contemporaneous beds of Niagara and Wenlock. It occurs at Lockport, (New York,) and Springfield, (Ohio,) in the magnesian limestone where it is associated with the *Pentamerus oblongus*. In the metalliferous region of Illinois and Wisconsin, it is found in general also at the base of the upper stage of the Silurian system; nevertheless we saw at Galena a specimen in the blue limestone, with species of the lower Silurian stage.

Homalonotus delphinocephalus, Green, sp.—This species, characteristic of the Niagara and Wenlock beds, occurs at Lockport and Rochester. It is necessary to unite with this species the *H. atlas*, *gigantcus*, and *herculaneus* of M. de Castelnau.

Chirurus insignis, Beyr.—This species of which we have the head well characterized, has been discovered by Mr. Troost in Perry county, (Tennessee.) and by us in the siliceous limestones of Chicago, (Illinois.) In these two points it belongs to the upper Silurian stage, and occurs in beds which we consider as

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* [We are not prepared to agree with M. de Verneuil in writing all these as a single species. The European species presents differences of character which separate it from all the American forms, and that from the Delthyris shaly limestone of New York, and that from the Schoharie grit are totally distinct species, while that in the Hamilton group is unlike either of them. The one in the Schoharie grit has a row of short spines down the back, but usually being preserved as casts, this character is overlooked and the general form relied upon. These differences, between American specimens, and between American and European, will be more fully detailed in the Palæontology of New York, vol. ii.]

higher than those which contain *Pentamerus oblongus*. In Bohemia, according to Mr. Barrande, the *C. insignis* occurs in an analogous position, that is to say, in the middle division of the upper Silurian stage.*

Sphærexochus mirus, Beyr.—This very remarkable species is found at Springfield, Ohio, and at Madison, Indiana. At the first locality it is associated with the *Pentamerus oblongus*; in the second, it is found at the summit of the great cut through which the railroad passes in the limestones which are at the junction of the two great stages of the Silurian system.

In Bohemia it is also at the base of the upper Silurian stage that this species has been discovered. The museum of Dudley possesses a specimen found in the limestone of that city. In Sweden it descends into the lower Silurian stage, for under the name of *Calymene clavifrons*, Hisinger has figured the head of a trilobite from Furudal in Dalecarlia, which appears to us very like the species in Bohemia. Nevertheless if the figure is exact there must be some difference.

[We have copied entirely the remarks of M. de Verneuil upon the fossil fishes and trilobites common to the two countries. For the remainder of the species cited by him we refer to the table appended, mentioning only those on which we make some comments. The absolute identity of species and similarity of position of many of the trilobites in the two countries is very remarkable, and much more conspicuous than in any other family of fossils. It is no less an interesting fact, that in nearly every important stage in the geological succession which we recognize in New York, there is almost a complete representation or re-creation of the types of the earlier period. Some forms are gradually lost it is true, while the principle or idea prevailing in those may be recognized to some extent in others. We may cite some examples.

The species of Trilobites with equal or nearly equal extremities, common in the forms of Illænus, Isotelus and Asaphus, are represented only by Bumastis in the Niagara group where this form ceases. The genus Lichas which first appears in the Trenton limestone, appears in the Niagara group in the form of the large and beautiful *L. Bolloni*. A very similar species occurs in the Delthyris shaly limestone and a fourth in the Corniferous limestone. In these four distinct and widely separated stages, the type is easily recognizable even from fragments, and the spe-

* [The head of this Trilobite has been found at the base of the Niagara or upper part of the Clinton group at Lockport, and in the shale of the Niagara group at Rochester. This fossil is clearly a species of the genus Ceraurus of Green, which name has precedence over that of Cheirurus. The *C. insignis* as it occurs in New York, bears much general resemblance to the *C. pleurexanthemus*. The latter must be regarded as the typical form of the genus.—J. H.]

cies of the Niagara group and that of the Delthyris shale have been regarded as identical.

The same observations apply with almost equal force to the different species of Ceramus. The type of Phacops appears in the Trenton limestone in the species P. Dalmani. In subsequent deposits this type is numerously represented, and the forms appearing in successive stages have not always been recognized as distinct species, though actually different.

This truth applies with equal force to other classes, and though the forms are less conspicuous, it becomes equally important to recognize their differences or agreement. The earliest type always better enables us to carry forward the idea in successive periods, and to refer varieties of form or species to a standard, than to make ourselves acquainted with the subsequent forms which have reference to that type.

I have given in the succeeding remarks some observations on several species of fossils cited in this paper, in instances where we think the original may lead to erroneous opinions, or where any new facts of importance have transpired.

Bellerophon bilobatus.—Since the publication of the first volume of the Palæontology of New York. two or three very imperfect specimens of a form undistinguishable from B. bilobatus, have been found by Col. Jewett in the Clinton group at Lockport.

Subulites elongata.—A second species of this peculiar genus has recently been obtained near Watertown, Jefferson county, New York.

Grammysia hamiltonensis [DeVern.], (*Pterinea bisulcata*, Conrad, Ann. Geol. Report, N. Y., 1838, page 116. *Cypricardites bisulcata*, Ann. Report of 1841, page 52.) This shell is very properly separated by M. de Verneuil from any previously established genus; but the name of the species, according to established usage, must give place to that proposed by Mr. Conrad. The species is remarkably abundant and widely extended in the Hamilton group, and the figures of M. de Verneuil are very characteristic.

Terebratula reticularis, Lin., (*T. prisca*, Schlot., *T. affinis*, Sow.)—It is difficult to believe that the great variety of forms which we find from the Clinton group to the Chemung group inclusive, are all of this species, though presenting a strong similarity of character. We may yet hope that the discovery of separated valves will enable us to detect characters, which will prove the well defined forms of the Niagara group and those of the Hamilton group to be distinct species.

Pentamerus oblongus, Sow.—This species though found in the United States at the base of the upper Silurian stage, is regarded in Europe as belonging to the lower stage. There can be no question as to its uniform position in this country, and as we have

elsewhere said, we believe the beds containing this fossil in Europe will be found to belong to the upper stage. Thus far no species of Pentamerus is known in the lower Silurian stage, and we feel much confidence in the theoretical views which we entertain regarding the progressive development of types which would not admit of such a form in the lower stage.

Spirifer sulcatus, Dalm., (*Delthyris decemplicata*, Hall).—"This species occupies at Lockport the same position as in the island of Gothland." We have no doubt of the identity of our species with the European one after having had an opportunity of comparing authentic specimens.

S. crispus, Dalm., (*D. staminea*, Hall).—This species which is frequently confounded with the last, is entirely distinct, and is also identical with the Swedish species.

"*S. bilobus*, Linn., sp. (*S. sinuatus*, Sow., *S. cardiospermiformis*, His.: *Delthyris varica*, Conrad.)"—"This remarkable little species of the Wenlock stage is found in the equivalent rocks of Rochester, New York; but it is even more abundant in more recent beds, that is to say, in the *Delthyris* shales; it is to this one that Mr. Conrad has given the name of *D. varica*, which is distinguished from the other by a shorter hinge, by its general form being more enlarged and by a more profound sinus. A careful comparison of the two varieties with the *S. bilobus* of Europe induces us to reunite them."

We regret to feel compelled to differ from the opinion of so careful an observer as M. de Verneuil, but in this case we cannot hesitate to pronounce the two varieties of form in question, very distinct species. The Niagara species is doubtless identical with the Swedish one, while the other differs in being much larger and having both valves convex. Of the *D. varica* we have some thousands of specimens and even in the smaller ones, corresponding to the Niagara species in size, we find a marked contrast. The differences between these two species of the two stages is equally as great in proportion to the size of the specimens, as between the *Delthyris crispa* of the Niagara group and the *D. cycloptera* of the Delthyris shale, or between *D. sulcata* of Niagara and *D.* —— of the Delthyris shale.

Orthis hybrida, Sow.—The species occurring in the Niagara group and the one in the Delthyris shale are quite distinct, as we shall be able to prove by specimens and figures.

Favosites gothlandica, (Goldf. sp.)—We are not confident as to the wide geological range of this species, though it probably occurs in the Silurian and Devonian systems. We have nevertheless been unable to find a characteristic specimen in the Clinton and Niagara groups: those which we have long referred to it proving to belong to an entirely distinct genus. There is however a species of Favosites in the Niagara group, but it occurs in small irregular forms and it is not easy to decide its specific relations.

Catenipora escharoides.—This species in all its varieties of form is confined to the Clinton and Niagara groups of New York. I have taken some pains to ascertain the facts in relation to the Caledonia specimen cited by Verneuil, as received from Col. Jewett. It proves to have been obtained at a place even higher in the series than Caledonia, but the mass was a transported block of the Niagara limestone, such as are often found either at the base of the terrace formed by the Corniferous limestone or in the valley along the base of the Hamilton group; the latter position is the one in which the specimen in question was obtained.

It is not for a single species that we care to contend, neither its identity nor geological position, but the integrity of the whole system depends on maintaining the truth under all circumstances. The views I advanced some years since in reference to the geological position of the Catenipora have never been controverted by the production of a specimen from any higher position than the Niagara group.

There are among the list given by M. de Verneuil, several other species the identity, and geological range of which we feel disposed to question, but at present we have indicated only those of which there can be no doubt. We feel conscious that this subject may be viewed and treated in two extremes. On the one hand there are, and have always been, those who consider the species of different beds as identical when they bear some general resemblance to each other; on the other hand there are a few, who seeing the evil of this course have gone to the other extreme, and regard *a priori* species from different beds as distinct. We confess that we have more confidence in the latter than the former course, though we cannot fully agree with the practice. We do not hesitate to say, that a difference between similar forms from different geological stages is to be regarded as of more importance than when the specimens are from the same bed. It not unfrequently happens that these slight obvious differences of specimens from different beds, prove to be connected with other and more important differences which were not obvious on first inspection, and which are often developed by an examination of the interior of the fossil.

In these respects M. de Verneuil pursues an intermediate course, with, as it appears to us, a leaning towards the previous opinions and views of geologists and palæontologists, which his own acute powers of observation so often prove to be erroneous or partial. In this place we may mention too the practice of referring to previously established genera all the fossil types. This has been so much the practice, that little progress has been made in just discrimination till within a few years past. To show how far this opinion or prejudice has prevailed, we need cite only the genus Productus which for a long time included all fossils of this

general form, and even others more remotely allied. We now have *Leptæna*, *Chonetes* and *Productus*, while the genus *Orthis* includes other forms previously referred to *Productus*. Still another genus of the Leptænidæ may be constituted, and we shall have a more natural subdivision than at present, each one possessing characters of important and peculiar value.

While M. de Verneuil recognizes and clearly establishes the genus *Chonetes*, we are surprised that he should unite all the Terebratuloid forms in the genus Terebratula, when there is ample room for subdivision. We believe, however, that we understand the motives of M. de Verneuil; and we cannot but admire the manifestation of this most scrupulous and sensitive reverence for the labors of his predecessors.

There is likewise in other families much room for improvement in establishing genera and applying characters, in more strict reference to their true meaning. This, perhaps, cannot be done entirely until the true principle of progression among types is fully established, or better understood than at present.

As American geologists, we are all much indebted to M. de Verneuil for giving us this sketch of his examinations in this country. Coming fresh from his extensive explorations in Russia and the northern parts of Europe, with Sir R. I. Murchison, and with an intimate knowledge of other portions of the continent, and all that had been previously done in the investigation of the palæozoic strata, no other person could have presented so clear and perfect a coup d'œil as we have in this paper.

In concluding this subject, two points of interest present themselves as of special importance, namely, the line of demarcation between the Silurian and Devonian systems, and that between the Devonian and Carboniferous systems. We have space only to glance at the first of these. It appears clearly established, judging from the facts advanced and opinions expressed by M. de Verneuil, that the horizon recognized in Europe as the base of the Devonian system, finds its parallel at the base of our upper limestone series of the Helderberg, or at the bottom of the Schoharie grit. The Oriskany sandstone must remain for the present debatable ground. This horizon, when traced westward, passes through the cliff limestone, leaving its lower part, which is a continuation of the Niagara group, in the Silurian system, and the upper part, corresponding to our Onondaga and Corniferous limestones, in the Devonian system. Thus it would appear that we have all doubts removed as to what is recognized as Devonian in Europe, and however disposed we may feel to question the propriety of such subdivision, we are satisfied to know its recognized limits.

It is not a little remarkable, however, that there still exist so many real causes for difference of opinion in relation to the limits

of the Silurian and Devonian systems. In the second volume, part I, of the Memoirs of the Geological Survey of Great Britain, several species of what are termed *Orthonota*, but really, as we think, *Grammysia*, are figured from the Silurian strata of Great Britain, while others of *Mytilus* are very similar, if not identical, with species from the Hamilton and Chemung groups of New York. Thus far I have never seen, in the State of New York, nor in any of the western states, a single species of bivalve of the character of *Grammysia*, below the Corniferous limestone, or even below the Hamilton group. These cingulated or obliquely furrowed and banded bivalves, are regarded as unerring guides to the eye, of the formations; and adopting the view of M. de Verneuil, as to the horizon of the Devonian, they are all above the Silurian system. There is still some mystery to us, on this side of the Atlantic, how the Ludlow and Wenlock rocks should contain fossils so very analogous to our Hamilton and Chemung fossils, and still be of Silurian age, while many of the Devonian Brachiopods of England are found mingled with these fossils in the groups referred to here. If it be true that these fossils are of Silurian age, and the line of division assumed here be the true one, then in this country we should have, above our upper *Pentamerus* limestone, a group of Silurian strata producing fossils analogous to those described by Mr. Salter. For, notwithstanding there may be a want of identity in species, the development of types has always proceeded *pari passu* with the successive depositions over the whole globe, so far as our knowledge extends.

Taking another view of the case, however, and regarding our Hamilton and Chemung groups as equivalent in age to those groups of England from which such similar fossils are obtained, we must carry the Silurian limit to the base of the old red sandstone, which, indeed, appears to be the natural and true horizon of its upper termination. This view we think is sustained when we regard the totality of the species, and the palæontological evidence on which we found subdivisions. For the whole United States, this would be attended with less difficulty than any other mode of subdivision. Still we must regard the fact of the introduction of the genus Productus, and some other forms allied to those regarded as Carboniferous types, at the time of the corniferous limestone; and the increasing number of these forms, as we ascend, till the higher part of the Chemung group bears a close analogy with the yellow sandstones of Ohio and Indiana, which are regarded as of carboniferous age.

These remarks are made in order to call attention to the fact, that there is still room for doubt and discussion on this point, and that on palæontological evidence, there is no well-marked line of separation, separating what may on one side be termed Silurian, and on the other, Devonian.]

Art. XXI.—*General Rule for Involution and Evolution by Logarithms;* by J. L. Riddell, M.D., Professor of Chemistry.

Having recently had occasion to use decimal exponents, in the involution of decimal quantities; and not finding in any mathematical works at my command, any directions or rules therefor, sufficiently explicit, it became necessary to seek out *de novo* some certain and convenient plan of operation.

To the following method, among several, I give preference; and I offer it for publication, (though I cannot flatter myself that it will be found by mathematicians to possess novelty,) because I am sure it may prove convenient and reliable to students and others, especially in the management of decimal quantities with decimal exponents.

The truth of the method must, upon inspection, be so obvious to mathematicians, as to render an accompanying demonstration unnecessary.

Precaution.—Let the numerical quantity to be involved, and also if convenient the exponent, be expressed in integers or decimals, or both if necessary.

General Rule for Involution and Evolution.

Take the decimal part of the logarithm of the numerical quantity from the tables, and make the index equal the number less by 1 than the number of places in the quantity from the first significant figure or place on the left, to the last figure on the right. Multiply this logarithm by the exponent, and from the product, subtract the product of the exponent into the number of decimal places in the quantity; the remainder will be the logarithm of the root or power sought, with its appropriate index and sign.

In order to express this rule by symbols,

Let Q = the numerical quantity to be involved or evolved.

Dec log Q = the decimal part of the logarithm of Q.

R = the root or power sought.

M = the exponent.

N = number diminished by unity of integral and decimal places in Q, from the first significant figure on the left, to the last place on the right.

D = number of decimal places in Q.

The formula then becomes

$$M(N+\text{dec log } Q)-MD=\log R.$$

Example 1.—Let it be required to raise 0·111 to the 0·0111 power.

Then dec log Q = ·045714 1. M = 0·0111. N = 2. D = 3.

$0{\cdot}0111 \times 2{\cdot}045714\,1 - 0{\cdot}0333 = -1 + {\cdot}8837782 = \log R$, the corresponding number of which is 0·7652.

Example 2.—Raise 10 to the 4th power.

Here Q = 10. dec log Q = 0. M = 4. N = 1. D = 0.

$4 \times 1 - (4 \times 0 = 0) = 4$ or $+4$. = log of R.

Hence R = 10000.

Example 3.—Required the cube root of 0·000111.

Here dec log Q = ·0457141. M = $\frac{1}{3}$. N = 2. D = 6.

$\frac{1}{3} \times 2{\cdot}0457141 - \frac{1}{3} \times 6 = -24{\cdot}6819047 = \log R$.

Hence the cube root of 0·000111 is 0·048073.

Branch Mint, New Orleans, October 9, 1848.

Art. XXII.—*Abstract of a Series of Experiments on Diamagnetism*; by H. C. Ersted of Copenhagen.*

At the session of the Royal Society of Science at Copenhagen on the 30th of June, (1848,) I presented the results of researches which I had made in diamagnetism, and I gave a report of the same in the Comptes Rendus of the Society. In the recess of this Society I have continued my researches and obtained many new results. As the memoir will not appear in the Society's Transactions in many months, I have decided to give an abstract of my results which can be communicated to my foreign friends.

My researches relate to the celebrated discoveries of Dr. Faraday, and to the developments which these have received from the German philosophers.

Dr. Faraday encountered in his experiments with his great electro-magnet, a class of bodies which are repulsed by the two poles of the magnet. This repulsion had been for a long time well known in the case of two or three substances, but the researches of the illustrious English philosopher have given to this fact a generality and an importance which has rendered it the object of attraction by all men of science. M. A. Brugmanns had as early as 1778 noticed that bismuth was repelled by the two poles of the magnet. M. Becquerel (the father) observed this repulsion anew, as relates to bismuth and antimony. Dr. Faraday found that his great electro-magnet produced this repulsion upon almost all bodies which it *did* not attract. He discovered also that bodies having unequal dimensions of length and breadth, when thus repelled under the influence of an electro-magnet, took a position perpendicular to that which an attractive body would take under the same circumstances. This is the property which he calls *diamagnetism*.

M. Reich of Freiberg, well known by his beautiful experiments upon the lateral deviation in the descent of bodies which fall to the

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* Translated for this Journal from the Ann. de Ch. et de Phys., Dec., 1848.

earth from a great height, applied to the discovery of diamagnetism the observation, neglected by other philosophers, that the two poles of the magnet employed together did not produce upon the body a repulsion equal to the sum of the repulsions effected by each, but equal to their difference; to the end—that their united effect would be null when their forces are equal. At the same time he made some experiments which seemed to indicate that the pole repelling a diamagnetic body, produces in the adjoining parts of another diamagnetic body a magnetic force like its own. M. Wilhem Weber confirmed the idea of M. Reich by his learned researches, and showed that diamagnetic bodies receive by the influence of an electro-magnet, a transversal magnetism having two poles, but so disposed that each of them has the same sort of magnetism as the nearest pole of the electro-magnet. M. Poggendorff contrived other experiments of a decisive character that have the advantage of proving the idea in an easy manner; and M. Plucker adds also a new experiment which increases if not the certainty of the result at least the facility of arriving at it.

These are the labors which served as a starting point for my researches. I used for my experiments the great electro-magnet of the Polytechnic School of Copenhagen, in the form of an U, and capable of supporting 1,400 kilogrammes.* Meanwhile it may be remarked that it was not necessary to put all its force in action for these experiments; but we rarely used less than half of this force, although the greater part of them could be executed with a much more feeble power, even with one element. Each extremity of the electro-magnet carried a piece of iron horizontally which we call a polar-piece. These polar pieces serve to give to the action of the electro-magnet a horizontal direction. It is between the two perpendicular faces situated vis-a-vis to one an-

* I here conform to the ordinary manner of indicating the force of a magnet; although uncertain, it has been proved upon this electro-magnet and communicated to the Royal Society in their session of 17th Dec., 1847. In these experiments the weight which the electro-magnet was capable of supporting, was tried when its poles were armed with different masses of iron. To certain limits the supporting power increases very nearly in proportion to the mass of the armature. But that which most merits our attention is that the force of the electro-magnet, expressed in weight, does not bear the same ratio to the electro-motive power of the galvanic machinery whilst the armature is in contact with the electro-magnet and when at a distance from it. In contact, the mean power of each galvanic element was 7125 kil., but two elements united gave only 0·72 the sum of power of each element, three elements united gave only 0·42, eight 0·26, sixteen 0·125, the sum of each power; to the effect that sixteen elements were only double the power of one element. At the distance of 1·33 mm. the effect of one element was only 0·178 of that of the same element, in the case of contact; but the product increases quite differently with the number of the elements. Sixteen elements give here four times the product of one alone. At the distance of 2·225 mm. the product of one element was only 0·051 of that produced in the case of contact; but sixteen elements gave 9·4 times the product which one alone gave. These researches which demand much time will be pursued as soon as my other occupations will permit.

other, that the diamagnetic body is made to oscillate. These faces we call polar faces. In all cases where I have not indicated exceptions I have used the rectangular pieces: at the commencement of my experiments I made use of cylindrical pieces, but this form is less convenient for discovering all the circumstances which ought to be taken into consideration in these researches. A diamagnetic needle suspended horizontally between the polar faces takes, as is known, the situation called *equatorial* which is parallel to the polar faces, but if it is raised a little above the edge of the polar faces, it takes a direction perpendicular to the polar faces prolonged. This position is at the same time the axial; but we see from what follows, that it is the perpendicularity of the polar faces which is here to be regarded. This phenomenon presents itself with remarkable readiness, which renders this experiment very convenient for many diamagnetic researches. On turning away the needle from its position perpendicular to the faces, it oscillates back again. Its directive force goes on diminishing as it is raised above the polar-pieces.

This experiment has been made with many diamagnetic bodies, with bismuth, amber, nacre of pearl, the shell of the tortoise, with alabaster, quills, sulphur, and pit-coal. The variation of the direction observed in these experiments, is lost in proportion as the polar faces are removed from one another. At a distance of seventeen millimetres the effect was still well marked, but it is much stronger at short distances. When the distance was diminished so far that the diamagnetic body could not enter between the polar faces, that is to say, in a position perpendicular to the polar faces, the part of the effect taking place above the polar faces showed itself with much force. When the diamagnetic needle is suspended above the upper edge of one of the polar faces, it takes equally the position called axial, perpendicular to this edge, but with less force than when under the influence of the two faces. On examining the position which the needle takes above the other edges of the polar-piece, it is found to take everywhere a position perpendicular to the edge, to whose influence it is exposed. In the case where it is exposed to the action of two edges at the same time, it takes an intermediate position.

Above the edge of a wedge of iron placed with its base upon one of the poles of the electro-magnet, the needle took also a position perpendicular to this edge. Upon a cylindrical polar-piece, the needle with its centre above the edge of the polar face, places itself perpendicularly to this face; but when at some distance from the edge, it turned and took a position perpendicular to the line which might be traced parallel to the axis on the highest part of the cylindrical surface. When a perforated cylinder is taken for a polar-piece, if the diamagnetic needle be made alternately to descend and rise parallel to the polar face, we

find that this needle quits its parallel position and takes an axial one as soon as it is placed opposite the holes of perforation. For this experiment I use a needle of bismuth of only sixteen millimetres in length. In using the two polar-pieces together, you produce the same effect in a much greater manner.

When the diamagnetic needle is suspended between the polar faces, it has, according to the experiments of the German investigators already cited, the magnetic poles in a transverse direction disposed in such a manner that the magnetism of each side is of the same nature as that of the nearest pole of the electro-magnet. The easiest method of confirming this is that of Plucker, who introduced between the polar faces and parallel to them, a small bar of iron separated from the faces by some non-magnetic body. Since the sides of this bar receive influence by magnetism opposite to that of the nearest face, and also each side of the needle has the same magnetism as the face nearest to it, the needle, now held by two forces, oscillates with much greater rapidity than when under the influence of the polar faces alone. When the diamagnetic needle is raised above one of the polar-pieces, so as to change its direction, its magnetic poles change their place at the same time. At the beginning I had been led into error by many phenomena, which in the novelty of the researches seemed very complicated, but now appear very simple since the law is found. At the commencement I believed that the diamagnetic needle above the polar-piece, had in each extremity magnetism opposite to that of its neighboring polar-piece; for the lower part of a bar of iron influenced by the piece, repelled the extremity of the needle which was above the piece. I have found this effect not only in placing the repelling pole of iron near each side, but equally above and below. Yet the later experiments have refuted the conclusions which I had drawn from the first. I have found that a piece of iron which is not very small, receives from the polar-piece that acts upon it, a magnetic force quite strong for repelling the diamagnetic matter of the needle, in spite of the poles which it has received by the influence exerted upon it by the electro-magnet.

For discovering the diamagnetic poles in this case, it is necessary to employ very small pieces or plates of iron; generally they should be but two or three grammes in weight. In order to manage them more easily, I have attached them to plates of zinc or pieces of wood. By this means I became at last convinced that the lower part of the diamagnetic needle suspended above the polar-piece had the same magnetism as that, and that its upper part had the opposite. In experiments for this object, I have made use of a thin plate of iron of this form ℂ, attached to a bit of wood.

When this plate is placed upon the polar-piece, it has the same magnetism in its upper part as the polar-piece, and in the lower part the opposite. When the opening of this curve is opposite to

the needle, it attracts it; but when its upper part is below or its lower part above, it repels it. When the needle is so suspended upon one of the polar-pieces that the prolongation of one of the perpendicular faces cuts the needle into two parts, we find that the diamagnetic poles produced by the electro-magnet extend beyond that part which projects over the upper surface of the piece. In these experiments made with a needle of bismuth of fifty-six millimetres, this effect extends hardly fourteen millimetres. When the needle was cut in two equal parts by the perpendicular faces prolonged, we found that the extremity of the needle most remote from the polar-piece was without polarity. When the electro-magnet was armed with two polar-pieces, placed at a distance of forty-eight millimetres, I found that the same needle had diamagnetic poles in all its parts. The half of the needle which was turned towards the north pole, had northern magnetism upon its lower edge, and southern upon its upper edge; the other half of the needle had by the influence of the southern pole, the magnetism of this pole upon its lower edge and of the northern upon its upper edge.

There is then an opposition of magnetism in the two halves of each edge taken separately, and in each half between the two edges, the upper and lower.

When the diamagnetic body is made to oscillate between the polar faces, we find that it makes its vibrations with much more strength when it is nearer one edge of this face.

In an experiment in which the electro-magnet was acted upon by sixteen of Bunsen's galvanic pairs, and where the distance of the polar faces was six millimetres, a needle of bismuth being at an equal distance from the upper and lower edges of these faces, made in thirty seconds twenty-five oscillations; but on a level with the edges, it made in the same time one hundred oscillations. Above the polar-pieces in an axial position, the needle made only nineteen oscillations in the same time. These experiments have been sufficiently repeated and varied to give perfect certainty to what is here announced, but the researches have not yet been pushed far enough to deduce an exact numerical law.

When a horizontal needle of bismuth is suspended to the extremity of a balance by a thread of silk, in such a manner that it can descend or rise, the needle is much more strongly repelled when it finds itself near one of the edges of the polar faces. This repulsion causes the needle to rise when it is near the upper edges, and to descend when it is near the lower edges, and in the intermediate position it neither mounts nor descends. When it is suspended above the polar-pieces and consequently in a direction perpendicular to the polar faces, it is still repelled though much more feebly than when in the equatorial position.

We have hitherto known only the diamagnetic effects in bodies which are repelled by the electro-magnet. My experiments have

shown that a similar effect is produced in most bodies which are attracted by the two magnetic poles; and these constitute a new species of diamagnetic bodies. We therefore distinguish two classes, *repelling* and *attracting* diamagnetic bodies.

A needle made of a body capable of being attracted by the magnet, but of which the magnetism is not of the same nature as that of iron or nickel, suspended between the two polar faces of the electromagnet, takes as is known, the position called by M. Faraday, axial; but if made to rise above the upper edges, or descend below the lower edges of the polar faces, it takes an equatorial position.

The bodies in which I have already found these properties are platinum, palladium, iridium, titanium, an alloy of 0·825 tin, 0·024 of bismuth, 0·108 of iron; brass, argentan, charcoal, coke, (the pit-coal is believed to belong to repelling diamagnetic bodies,) obsidian, native carbonate of iron, attracting glass, Prussian blue, and the solutions of iron. In the greater number of these bodies the magnetic poles which are obtained during the influence of the electro-magnet, are lost as soon as the influence ceases: notwithstanding they betray themselves when the poles of the electro-magnet are suddenly changed; for then many of these bodies turn half a circle, as a magnetic needle would; others do not turn entirely, but oscillate enough to show their tendency to change positions. But some attracting diamagnetic bodies, such as a piece of iridium in my possession, charcoal or coke, retain for a longer time the poles which they have acquired. The experimental researches upon the phenomena of these bodies are complicated by this duration of polarity, but they will probably lead to the discovery of the relation which exists between magnetism and diamagnetism.

When a needle made of an attracting diamagnetic body is suspended above the upper or below the lower edge of the polar-piece, it takes a position parallel to this edge. In this parallel position, which can as well be either perpendicular to the magnetic axis of the polar-piece, or parallel, or in any other position conformable to the figure of the polar-piece, the disposition of the magnetic forces in the needle is transversal, as in a repelling diamagnetic body, but with this difference, that the lower part has a magnetism opposed to that of the polar-piece, and the upper part to that of the same nature.

I have not yet succeeded in putting iron itself into a diamagnetic state. An iron wire of only one-tenth of a millimetre in diameter, takes an axial direction as well above as between the polar faces, and that with a force which seems nearly sufficient to break a silk thread. To vary this experiment, I put into a quill (which is repellant) a fragment of the same wire, that was only two millimetres long; but this presented the same effects as when the iron was alone. The same effect is obtained by repla-

cing the wire by a very thin particle of iron filings; but upon introducing in place of the iron a piece of straw which had been plunged into a solution of iron, the diamagnetic effects were those of attracting bodies. Nickel gives the same results as iron. Thus iron and nickel ought to be called, in a strict sense, magnetic. Some other bodies may be of the same kind; I presume cobalt is.

There is then a decreasing magnetic progression which includes magnetic bodies properly so called, diamagnetic attracting bodies, and diamagnetic repelling bodies. The magnetism of the last may be considered as negative, if the magnetism of iron and of attractive diamagnetic bodies be considered positive.

The effect which the polar faces exert upon the attractive diamagnetic bodies is, as regards a relation to the repellants, stronger when the body is placed nearer the upper or lower edges than their intermediate parts. A piece of attracting glass, twenty-seven millimetres long, suspended between the polar faces, at a distance of twenty-nine millimetres, in such a manner that the ends of this needle were not farther from the polar faces than one millimetre, was oscillated each time for thirty seconds. At an equal distance from the upper and lower edges it made only 4·5 oscillations in thirty seconds; but on a level with the polar faces, it made 19.

When the polar faces are at this distance, the needle does not take the equatorial direction when it is suspended above their edges. At a distance of 4·5 millimetres, it made only 5·5 oscillations. At a distance of 13·5 millimetres, it made only 2·5 oscillations. On approaching the polar faces even to three millimetres, the needle which now could not take the axial direction between the faces, still showed all its tendency to take that position; but raised at a distance of two millimetres above their edges, it took the equatorial position, and made 18 oscillations in thirty seconds. At a distance of three-tenths of a millimetre it made 35 oscillations. At the nearest point at which it could escape contact with the polar-pieces, it made 45 oscillations.

Diamagnetic bodies, therefore, repellant as well as attractive, have their oscillations more numerous in a position parallel to the polar faces, than in a perpendicular one. It is to be remarked here, as has already been done upon another series of experiments, that the determinations of numbers have not been sufficient to give the exactness necessary for calculating their laws.

I have lately made some experiments upon the influence of heat upon diamagnetic bodies. These experiments have not yet been sufficiently numerous; but they show that some attracting diamagnetic bodies pass into the class of repellant diamagnetic by an increase of temperature. The only body which has shown me this effect in a high degree, is brass. My analogous experiments upon other bodies are not yet sufficiently decisive to be reported here.

ART. XXIII.—*Abstract of a Meteorological Journal, kept at Marietta, Ohio, Lat.* 39° 25′ N., and Long. 4° 28′ W. of Washington City; by S. P. HILDRETH, M.D.

MONTHS.	THERMOMETER. Mean temperature.	Maximum.	Minimum.	Fair days.	Cloudy days.	Rain and melted snow. In. and 100ths.	Prevailing winds.	BAROMETER. Maximum.	Minimum.	Range.
January, - -	36·—	60	3	17	14	2·04	W. N. & S.	29·90	29·—	·90
February, -	37·—	67	17	16	13	1·33	N. W. & S. E.	29·70	29·05	·65
March, - -	39·33	83	5	16	15	3·00	W., N. & S.	29·80	29·10	·70
April, - -	53·78	85	24	25	5	1·38	S., N. & S. W.	29·80	29·30	·50
May, - -	64·75	87	37	18	13	5·66	S. & N.	29·58	29·20	·38
June, - -	67·66	89	43	23	7	3·25	S. & N.	29·58	29·25	·28
July, - -	69·66	86	50	16	15	8·05	S. E., S. & S. W.	29·55	29·10	·45
August, - -	70·—	88	53	19	12	4·86	S. E. & S.	29·60	29·25	·35
September, -	59·33	82	34	23	7	1·08	S. & N.	29·63	29·10	·53
October, - -	51·66	76	32	16	15	3·09	N., S. & S. E.	29·68	29·05	·63
November, -	38·—	62	22	14	16	2·86	W. & N.	29·70	29·05	·65
December, -	42·66	69	20	8	23	6·58	S. W. & N.	29·93	29·05	·88
Mean for year,	52·50					43·18				

THE mean temperature for 1848 is 52°·50, which is very near the usual degree of heat for this place, and accords with that of our wells and springs, which are allowed generally to be correct tests of the mean heat of the year. The mean indicated by the thermometer varies a degree or two in different years, owing to very hot summers, or extreme cold winters; rising as high as 54° for some years, and sinking as low as 50° for others, forming quite a variety in a series of years.

The amount of rain and melted snow was forty-three inches and eighteen hundredths, while in 1847 it was fifty-two inches and thirty hundredths, this being the year of the great flood in the Ohio river, in the month of December. Heavy rains attended the winter solstice this year, as they almost invariably do at this period, every year; wet weather is much more certain at this period than at the equinox.

The mean temperature for the winter months was 36°·11, for the spring 52°·59; summer 69°·10, and for the autumnal months 49°·70.

The year which has just closed has been rather remarkable for its equable temperature. The greatest cold was at 3° above zero, on the tenth of January; and the greatest heat at 89°, on the 27th of June. In July, August and September, it seldom rose above 80° in the hottest season of the day, doing so only on eighteen days; while in the year 1846, it rose above this point on fifty-nine days, standing at 91° and 92° several

times; showing great inequality in the temperature of our summer months.

The crops of grain and fruit were generally very good, fully equal to those of any previous year, especially in the production of apples and peaches. The growth and ripening of melons was much retarded by the coolness of the summer; while the excessive rains of July, over eight inches in depth, not only rotted the roots of the vines, but greatly injured the grapes, causing a mildew and blight on the foliage and fruit. Apples were never finer, and that portion of Washington county bordering on the Ohio river furnished twenty-three thousand barrels for the markets, above and below Marietta. The soil and climate are admirably adapted to the growth of the apple, and no portion of the United States can show more perfect fruit than that seen in the orchards of the Ohio valley.

The mean of the spring months was fifty-two degrees and fifty-nine hundredths; the heat of May being somewhat greater than in some years, exceeding that of 1847 by about three degrees. Spring frosts were less destructive to fruit blossoms than common, and where they prevailed did not kill the germs, as they do in some years. A smart frost on the 15th day of April, when the plum and pear were in bloom, and the peach had not yet shed its petals, although the temperature fell to 28°, did not much injure the fruit, as full crops of all but cherries were produced. This variety of fruit having been very abundant the year before, may account for its failure, as trees which have rested one year will bear much more frost the next, having acquired vigor by the period of rest, and more able to resist the action of cold than trees somewhat exhausted by a previous full crop of fruit.

Floral Calendar for 1848.—February 20th, Garden Crocus in bloom, and honey-bees at work on their blossoms.

March 24th, Garden earth so dry as to admit of working, and the seeds of various esculent vegetables were planted. 29th, Hyacinth in bloom. N. B. In this month snow fell to the depth of three inches, on the 3d and 9th. On the morning of the 4th, the thermometer fell to 5° above zero. Peach-trees were quite forward, showing the rich color of the unopened petals, the size of a small pea. It was feared that this great depression of temperature would destroy the vitality of the embryo fruit; but as the germ was protected by the leaves of the unexpanded flower, it escaped unharmed. It is a wonderful provision of nature to protect the fruit bud, although far advanced in its progress towards maturity.

April 1, Hepatica triloba in bloom; this is usually out in March, as early as the 15th or 20th. Peach nearly in bloom. Apricot in blossom, but killed by the cold in March; 5th, Peach

in full bloom; 6th, Sanguinaria canadensis; 8th, Primrose and violet; 10th, Imperial gage; 11th, Cherry and pear; 13th, Ranunculus sylvan; 14th, Dodecatheon media; also Pyrus japonica. N. B. This shrub is two weeks later than common in blooming; 16th, June berry; 17th, Portugal quince; 18th, Apple-tree; 19th, Some snow fell—half an inch—on the morning of the 20th; thermometer at 24°; 20th, Judas-tree; 22d, Chickasaw plum. N. B. Put out dahlias, tuberoses and lilies, in the open ground. 23d. Common quince in bloom; 24th, Yellow violet, and Uvularia; 25th, Harebell; 27th, Buckeye; 28th, Garden Ranunculus; 29th, Cornus florida.

May 1st, Hickory-tree in bloom; 2d, White walnut—Apple shedding its blossoms; 3d, Papaw—garden tulips in full bloom; 4th, Black walnut; 15th, Yellow moccasin flower; 16th, Purple mulberry; 25th, Hovey's strawberry ripe; 27th, Osage orange in bloom.

June 1st, Frost this morning in the uplands, back from the river, on white-oak lands—here the thermometer was at 48°! On the 7th and 8th of this month, there was light frost on the uplands, three or four miles back—thermometer at 43° at sunrise. 12th, Russian cucumber fit for the table, grown in the open ground, protected in April by a small box with glass; 13th, Frost this morning on the outskirts of the town—thermometer at 40; the night being clear, the radiation of caloric was rapid. 14th, Purple mulberry ripe; 19th, Catalpa in bloom; 21st, Yellow and red Antwerp raspberry ripe; 26th, Hay harvest begins; 29th, Wheat harvest commences.

July 1st, Early Chandler apple ripe, and Golden-drop fit for eating, but not all ripe.

The mean temperature of the summer months was 69°·10, which is quite low. In 1846, it was 71°·05. July was excessively wet, there falling over eight inches of rain. Much wheat was damaged while standing in shocks, in the field, and a quantity of hay entirely ruined.

The potato crops also suffered greatly from "the rot," which is much worse in wet seasons than in dry. Some fields were ruined by a worm in the stalk, the egg being deposited by a fly in the extremity of the stem, and working downward in the pith. it wilts and rots, destroying the tubers. It is a new enemy to this valuable esculent. Some fields were benefited by mowing off the tops of the vines, and thus destroying the worm. Indian corn, that most valuable and nourishing grain of all the cereals, flourished and grew luxuriantly. It is a plant most admirably adapted to the wants of man and beasts, growing in the United States from their northern to their most southern limits, and when ripe for harvest, remains unharmed in the field for months, to suit the convenience of the grower; while other crops are lost if

not gathered at maturity. The mean of the autumnal months was 49°·70, about three degrees lower than in 1847; while December was unusually warm, 42°·66, or seven degrees above that of 1848. It was also very rainy, being 6½ inches; raising quite a flood in the southern branches of the Ohio, and threatening to repeat the freshet of last year.

Art. XXIV.—*On a new Protractor for Trisecting Angles;* by J. H. Alexander, Esq.

The problem of *the Trisection of the Angle*, as it has always been termed, was no doubt one of the earliest to attract the efforts of the ancient geometers. At least, it is very reasonable to suppose that immediately upon the discovery of the method of *bisecting* an arc, would follow an attempt to investigate the modes of dividing it into three or any number of unequal parts or, indeed, in general to divide it in any ratio. We have no evidence to show precisely when this was first undertaken; nor has the name of any philosopher come down to us, traditionally connected with the announcement or the history of such investigation, as is the case, for instance, with the rectifying lunules of Hypocrates or the duplication of the cube of Menæchmus. But as there is one Geometer, Dinostratus, to whom has uniformly been attributed the invention of the *quadratrix*, a curve capable of being applied to the solution of this very problem (although from the loss of all writings of his, we do not know the extent of the aim with which he applied it), we are warranted in ascribing the attempts at the trisection of angles to a period at least as early as his. And as he is reported to have been the friend and collaborator of Plato, we cannot be far wrong in fixing the date not lower than 400 B. C.; and a fresh association of interest is thus connected with the problem, in considering that for 2000 years and more its terms and conditions have occupied at some time or other the thoughts of all who have devoted themselves to pure mathematics.

The problem was further piquant; because it shewed three cases admitting of solution by strict geometric construction. These are the trisection of the circle, of the semi-circle and of the quadrant. One can, therefore, appreciate the peculiarly tormenting nature of the obstacle which, after the possession of so many steps, prevented the acquisition of more, and which might seem created expressly to batile, in what it refused, the curiosity that it stimulated in what it allowed. Of all geometrical problems, this was emphatically the *coquette*.

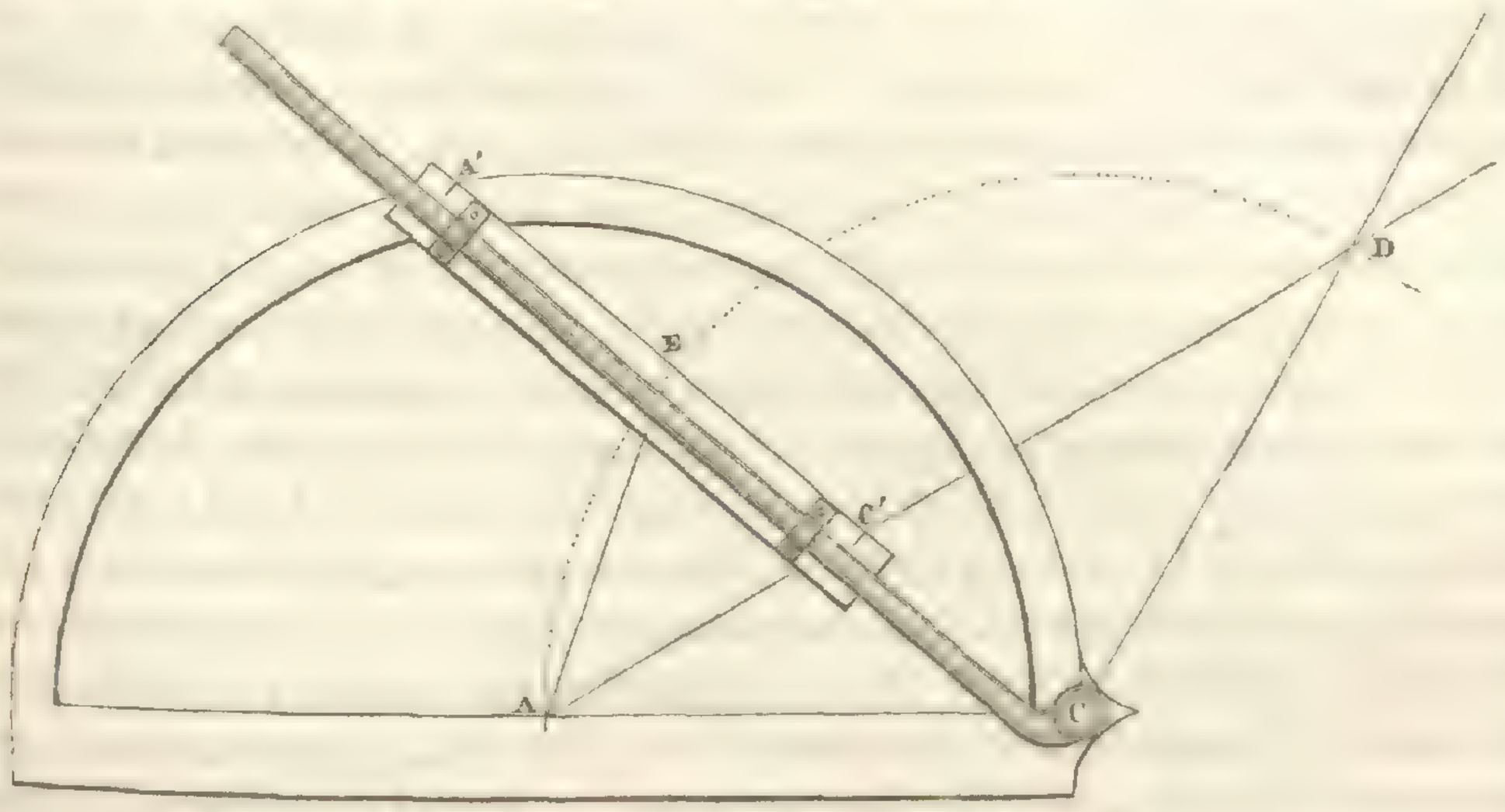
But such an epithet would be unjust, if it could apply to the individuality of the question itself; for the obstacle, in fact, lay

in the conditions prescribed for the research ; and the failure is to be ascribed (if we may continue the metaphor) more to the fastidiousness of the suitors than the caprice of the object. The severe synthetic geometry of the ancients admitted only fixed points and constructions upon lines drawn from or to such points. Hence *motion*, except around a fixed point (as for instance in the description of a circle) although neither unknown nor uninvestigated in that early science, found no place in the majestic stability which the school of Plato sought to uphold. It was only in despair (or perhaps he meant it to show what he could do if he would) that Plato himself resorted to a mechanical solution in effecting the duplication of the cube. The quadratrix of Dinostratus, therefore, as well as other methods that might have been proposed, involving sections of the cone, for the trisection of an angle, was classed in the interdicted caste of *mechanical* curves (as such figures were denominated) ; and so failed, in the verdict of antique severity, to be admitted among the triumphs of pure geometry. Modern times, less prepossessed or more just, have nevertheless made for it a niche in the history of the progress of human intellect ; and modern science, less strict and classical but more fecund, has seized on the idea and held it as a thread to guide among the intricacies of a more profound and wide-reaching analysis than that which wove it first. Abandoning the former inadequate distinctions of *plane* and *solid* and *hypersolid*, it has imparted a wider generality to the whole theory of curves; those that were before excluded as *mechanical*, it now treats as *transcendant ;* and for the present application, shews how, by the revolution of a cubic equation, the condition for trisection may be met.

But the elaboration and refinements of these methods of calculation, unfit them for practical use, as in the majority of cases where the result alone is wanted ; and I have thought, therefore, that it might be of some interest to present a mechanical method for effecting the purpose with as much accuracy as is desirable or necessary in most instances. This is done in the present description of the accompanying figure (p. 245) of a New Protractor for Trisecting Angles. New, I believe it is ; for it will hardly be found elsewhere ; but it is to be observed that its device does not require much ingenuity ; and its merit, if it should be allowed to have any, consists in its appropriateness and simplicity. An explanation of the principle on which its device reposes, will be at once the best introduction and commentary upon its mode of working and use.

Referring to the lines and letters in the figure which gives the projection of the instrument, if we have any angle ACD required to be trisected ; and with any radius AC, be described the arc AED with its centre at C ; and with the same radius but with

the centre at A, be drawn a semi-circle (which in the figure coincides with the outer circumference of the protractor) whose diameter passes through A and C and is thus coincident with one leg of the given angle; and the points A and D be joined by a straight line: then whenever of a radius prolonged from C the distance A′C′ intercepted between the straight line AD and the circumference of the semi-circle is equal to the original radius AC, the arc AE (cut off by a straight line joining A′ and C) is one-third of the original arc AD; or what is the same, the angle A′CA is one-third of the given angle ACD.



A New Protractor for Trisecting Angles.

These relations are very manifest; for, assuming the construction as given and supposing the triangles to be completed by joining the points AA′ and CC′ (which are in the figure left to be imagined), we have AA′C′ and ACE, two equal and similar isosceles triangles; and because isosceles, with the side A′C′ equal to AA′ or AC, that is, to the radius in question. Also ACE being an isosceles triangle, C′AE is likewise isosceles and similar, for both have AEC′ a common angle at their base. The angle EAC′ therefore is equal to the angle ECA. But the angle EAC′ (or EAD) at the circumference is subtended by the same arc ED which subtends the angle ECD at the centre; and is therefore one half of this last. The angle ACE (the equivalent of EAD) is then one half of ECD; and so is one-third of the given angle ACD, which is the sum of its double and itself, q. e. d.

In the device of the protractor, I have done no more than render permanent the essential parts of the construction. In point of fact, it is quite easy, with a little tact in manipulation, to dispense with apparatus at all more than a graduated scale and a pair of compasses, against whose point held at C, the scale revolves until the number of its divisions intercepted between the chord AD and the semi-circle previously described, equals the number assumed originally as radius. But as the management

of these separate pieces may be found cumbersome and inconvenient. I suppose the present combination to possess certain advantages. The body of the protractor, then, is a semicircle of metal or of ivory and of any diameter. A diameter of four inches, is about the most advantageous, for if it be much larger, it leads to the necessity of prolonging the line of the given angle—an operation not merely imposing additional trouble but introducing occasion for inaccuracy; and if it be much smaller, the possible error masked in the apparent coincidences becomes of course proportionally greater. There is no graduation on the protractor; only its centre is marked with A, for precaution and reference. At C, as nearly as possible in the intersection of the diameter and circumference, is centred the pin or journal on which the movable arm works; and the center should be marked here for the same motive as at A. The movable arm itself is a cylindrical steel wire, eccentric to its axis but parallel to the geometrical radius; and on it, slides, retained by two straps and hugging by a longitudinal faint spring inlaid beneath and not visible from above, the ivory scale $A'EC'$ of such width and so adjusted as that its fiducial edge shall coincide with any radius drawn from C and having the length of the original radius $A'C'$ marked with a fine perpendicular notch through and through. This notching instead of simply cutting on the surface, is to avoid parallax and to compensate for the obliquities of intersection, as well as to allow the point A' to be pricked on the paper or board, not external to, but in the actual line of the radius from C. The proper horizontality of the scale necessary to maintain the coincidence of its fiducial edge with such a radial line, is assured by the constant contact of its lower face with the plane surface of the limb (or if necessary of the diameter, through its whole extent) of the protractor.

After this description of the parts of the instrument and their adjustment, the mode of its use is very apparent. It is only necessary from the vertex of the angle given on the paper or the board to lay off on each leg a distance equal to the radius of the protractor; to draw a line joining the points respectively terminating such distance; and to lay the protractor so that its centre coincides with the terminal point on the left of the vertex and its fiducial diameter with the angular leg, when the point C will of course be adjusted to the vertex of the angle. Then holding the protractor firm to its place with one hand, with the other move at once both the revolving arm and the sliding scale until the base of the triangle and the edge of the protractor are seen at the same time through the notches A' and C. A fine needle pressed down at A' will then give the point through which after the protractor is removed, a straight line drawn to the vertex of the angle will lay off the trisection required.

Such trisection is not unfrequently desired in the geometrical drawings and designs in various branches of engineering; as for instance in carpentry, in church architecture and in fortification especially. For persons engaged in these branches, an instrument like the one I have described will very likely afford some interest.

ART. XXV.—*Notes on Upper California;* by JAMES D. DANA. From Observations made during the Cruise of the United States Exploring Expedition, under Capt. CHARLES WILKES, U. S. N.*

THE party with which the writer was associated on a tour from Fort Vancouver to San Francisco, was under the command of Lieut. G. F. Emmons, by order of Capt. Charles Wilkes. Our route lay between the Cascade Range and the sea.

On the 30th of September, 1841, we reached the Clammat (or Tlamath), a fine river just south of the parallel of 42°, and encamped on a narrow plain not far from its banks, near the meridian of 122¾° W. The lower elevations and the lottier hills around consisted of tertiary sandstone, dipping at an angle of 20°; while the summits of the principal heights were composed of basalt outcropping through the stratified rocks. The slopes were strewed with chalcedony and agates, that had fallen from the decomposing basalt, and the soil partook of the chocolate-brown color, loose texture, and fertility, usual where this rock prevails. Much of it was deeply cracked from drying during the long drought. The sandstone resembled the tertiary rock of Astoria, and was probably of the same age—the miocene. It was soft and friable, and of a grayish white color.

The view from a neighboring eminence was a pleasing one. An open prairie thinly covered with oaks, and bearing occasionally a grove of pines, lay spread out among grassy hills and other elevations bristled with evergreens. The Clammat seemed to flow along a narrow valley from the far east, and continued its course among the hills that broke up the country to the westward; and a streamlet with a border of shrubbery meandered over the plain towards the river. A rounded summit, exceeding one thousand feet in height, stood to the south-southeast, and shut from sight the snows of the Shasty Peak, a volcanic cone, twelve to fourteen thousand feet high, which had been in view from mountains just north of the Clammat.

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* The Geology of the region here treated of is described with more systematic detail in the Exploring Expedition Geological Report of the author, which is just now printed excepting the Plates. It forms a volume of 760 pages in 4to, to be illustrated by 3 maps, besides 21 plates of fossils in folio.

October 1.—The morning was, as usual, cool. At dawn the thermometer was down to 32° F., while at noon of the preceding day it had stood at 90° F. in the shade. We ascended the Clammat two miles, and forded the stream in 2½ to 3 feet water. It was 80 to 100 yards wide, and much of the way ran in rapids. Passing to the northward of the rounded summit just alluded to, over a region of sandstone hills, affording a dry soil and scanty vegetation, we next traversed for five hours an undulating prairie, much of which was as dry as the hills, and, besides, black and desolate from the recent fires. The prairie in some parts abounded in pebbles of milky quartz, indicating by their characters the existence of talcose rocks in the vicinity. A generous rivulet six to eight yards wide was finally reached, and afterwards a still larger stream, with green banks, afforded a good place for encampment. The two unite and flow northwestward into the Clammat.

After travelling upon this prairie for about six miles, we came to a low outcropping ledge of sandstone, extending across the plain from east to west, and dipping fifteen degrees to the northward. Nearly six miles beyond, we passed a heap of volcanic rocks, consisting of masses of grayish and reddish porphyritic lava, one to ten cubic feet in size, lying together in a disorderly pile. The rock contained crystals of glassy feldspar thickly disseminated. As we continued on, these heaps of lava blocks became numerous; and the plain was thickly covered with rounded and conical hillocks of broken lava, twenty to two hundred feet high—averaging sixty feet. A few had table summits. Although generally covered with soil, the black rocks outcropped at top, and lay scattered over the surface. This soil was a red or brownish-red earth, arising from decomposition, and it appeared remarkable that it was scarcely at all mingled with the alluvium of the plain: on the contrary, the soil of the prairie had the color and characters due to a sandstone origin, proving that this *Hillock prairie* had been leveled under water after the volcanic rocks were thrown up. In the course of about five miles, these hillocks of lava became so crowded together that the plain almost disappeared between their coalescing declivities; and we observed beyond, that still nearer the mountains, the country gradually changed to a region of rough rounded hills, which, increasing in extent, rose into high ridges lying at the northern base of the Shasty Peak.

A hundred yards from our encampment, a spot in the plain was covered with incrustations of salt, and salt plants (a species of *Salsola*) were abundant.

October 2.—Continuing southward, we had to the west, within half a mile, high smooth-featured hills, evidently consisting of sandstone; and about the same distance to the eastward, the region of volcanic hillocks already described. In several places

the ground sounded hollow under the horses' hoofs. Till noon, the soil was dry and pebbly, and mostly of sandstone origin. About midday we passed another saline with Salsolas, lying about fifteen feet lower than the usual level of the plain. The western hills afterwards became more bold in their features, and the rocks stood out in black points over much of their surface. The foot of one of the ridges, where crossed, proved to consist of a dark green serpentine; and pebbles of the same rock, bleached externally from exposure, were abundant. The rock contained amianthus and green diallage, its characteristic minerals. Half a mile beyond, near our encampment, the rock was a beautiful syenitic granite, or syenite, containing large crystals of hornblende, some of them two inches long. The ridges to the westward rose to a height of 1500 or 1800 feet.

The smoky haze which had concealed the Shasty Peak during our journey across the prairie, still continued, and although within twenty miles of its base, we could barely discern as if in distant space far above us, faint traces of its snowy summit in a few dim lines and shades.

October 3.—On the morning of the 3d the Peak was visible until half an hour before sunrise, when a thin haze again veiled it from view. Following up the small stream on which we had pitched our tents the night before, we soon reached its head and struck into the forests of the mountains. The high syenitic ridge had continued to bound our view to the westward, and a very uneven hilly region lay to the eastward; some hills of lava were passed within fifty yards of the syenite. The plains left behind had been partly covered with pines and were highly fertile. The mountains before us were a mass of lofty ridges ranging from east to west and situated to the west of the Shasty Peak. They form a natural boundary across the country, dividing the Clammat region from the district of the Sacramento; and where passed by us, they occupied a breadth from north to south of about forty miles, though twice this distance by the zigzag course we followed.

Entering the mountainous region, we travelled for several miles over trachytic lava and trachyte, which lay in mounds and ridges, or in scattered blocks among the trees. The rock had a light gray or grayish blue color, a nearly compact texture, a rough surface of fracture, and contained slender crystals of hornblende. It afforded in some places a light-gray ashy soil, which, near a burnt tree, was occasionally of a pale reddish tint from the action of the heat. We had several views of the Shasty Peak through openings in the mountains, and passed within a few miles of the foot of a lofty cone lying near its western base. This cone had regular sloping sides, and truncate top, and was evidently an extinct crater, made of ejected cinders. It retained all the freshness and regularity of a recent formation.

The Peak is one of the lofty volcanos of the Cascade range. It had two summits as seen from the southwest, and between them there seemed to be a depressed plain; but no distinct crater could be made out in the distant view. Each summit had probably been a separate place of ejection; the smaller appeared as if it might bear the same relation to the larger, as Vesuvius to Somma. The sides were covered with loose fragments, without vegetation where in sight, and had the ashy color of the trachytic rocks passed on our route. The snow was in banks or patches about the more sheltered parts of the top, and not in an unbroken coat, as about St. Helens. The declivities were in general but little broken; but the southwestern face, from the summit down three or four thousand feet, was intersected by projecting ridges of rock that stood out in points and walls and cast long shadows over the slopes; these shadows indicating a height of at least some hundreds of feet. They were evidently walls or dikes of volcanic rock filling former fissures in the crater, and now projecting owing to the removal of the rock material that enclosed them.

No time was allowed for closer exploration, as the party continued its course without stopping.

The only traces of existing fires in the vicinity of the Shasty volcano are found in a hot spring described to me by Mr. MacKay, as occurring to the east of the Peak, near a track sometimes taken by parties to California. It is said to issue from among the rocks, and my informant assured me that he had boiled eggs in its waters. The stream running from it had worn the rocks smooth and formed a small basin below, which was much frequented by the mountain sheep.

Obsidian or volcanic glass is said to occur in some parts of the Shasty region; but we met with none of it. The Shasty Indians use this material for their arrow-heads, which they work out with great skill and delicacy.

Within eight or nine miles of our preceding encampment a tributary of the Sacramento was flowing at our feet, and half an hour beyond, our camp was pitched on another of the streamlets flowing from the Shasty mountains and forming one of the beginnings of the large California river.

October 4.—The thermometer at 2 A. M. on the morning of the 4th, stood at 32½° F. We were off on our way through dense forests of evergreens, and soon left an undulating country by a descent into a gorge two hundred and fifty feet in depth. The rock thus far trachyte and evidently pertaining to the Shasty eruptions, soon changed to the talcose rock formation, and pebbles of quartz and talcose slate were abundant along the bed of a rivulet. Again we passed for a few miles to trachyte, and before finally leaving this rock, we came upon a small *Chalybeate*

The Shasty Peak—bearing by compass N E b N.

Spring, in the vicinity of Destruction river, the affluent of the Sacramento which the party thence followed on their way south.

Descending a few yards to a small plain on the border of the river, the spring was observed near by on our left. The water was oozing from among the rocks into a basin scarcely holding a gallon, and flowed down over a small marshy spot thickly covered with iron-rust. It was brisk and pungent with carbonic acid, and was called by the trappers *soda-water*. The taste was agreeably acidulous and chalybeate, without any thing saline or alkaline. Fifty yards beyond the spring, there was a shallow ditch a hundred yards long, containing about half a foot of water similarly chalybeate, but less brisk with carbonic acid. Our horses drank freely of it, and with good relish. The temperature of the spring was as cool as that of the mountain torrent near by.

The passage through the mountains occupied us from the 4th of October till the 10th. Destruction river was at first but a mere rivulet; it increased rapidly to a brawling torrent, and then to a large stream several feet in depth. It is a succession of cataracts through a great part of its course, affording scenery of the wildest character, as it dashes impetuously through its narrow defiles, over the rugged rocks. We seldom could travel even for a short distance upon its banks. Through our whole course, till we emerged upon the plains of the Sacramento, we were ascending and descending,—now up a rocky steep several hundred or perhaps a thousand feet high, and then to the bottom of the craggy valley. The view ahead varied but little: ridge beyond ridge appeared to interlock below along the river.

Soon after leaving the Chalybeate Spring, we were again on talcose rocks and syenite, and beyond soon passed to granite. From our encampment on the night of the 4th, a valley on the west opened to us a magnificent spectacle of needle peaks and lofty pinnacles of granite. This bold crested ridge was about three thousand feet high above the plain at its foot, and one massy peak overhung the valley. A few evergreen spires stood in the clefts of the ridge; otherwise it presented a bare surface of grayish-white rock. A whitish debris covered the slope at its base, and the valley was strewed with boulders of granite.

The granite of the region has a very light color and looked in the distance much like cliffs of chalk. It was generally albitic, containing white albite, either in place of feldspar, or associated with it. In some places the feldspar crystals disseminated through the albitic rock measured one and a half by two inches in their dimensions. The mica was usually in small black scales, but sometimes silvery: it was not abundant.

At one place the rock was a granular compound of albite and quartz. The granite passes gradually into syenite, first a few crystals of hornblende appearing in the rock, and then beyond, this mineral becoming a characteristic ingredient.

The syenite often contained albite. In some places, the crystals of hornblende in the white rock, were two or three inches long. One variety was a grayish rock thickly speckled with small square or rectangular spots of albite, the grayish base consisting of a mixture of albite and fine crystals of hornblende. This and many of the other varieties were beautiful rocks for architectural purposes. The syenite graduated into a variety consisting almost wholly of hornblende.

The talcose rock was either slaty or compact, and much of it had the characteristic soapy feel. An imperfect steatite or soapstone was met with, too hard and gritty for the ordinary purposes of this material. The compact variety has a siliceous or flinty appearance, though generally some dull greenish shade from the presence of a little talc or hornblende. It breaks with sharp angles and is usually much fissured.

October 5.—We continued our rugged way down the valley, up and down the hills that border it on the west, travelling over rocky declivities often covered with sharp broken stone and in many places barely accessible. The hills to the eastward were still higher and more abrupt, varying according to our estimate, from eight hundred to eighteen hundred feet. Destruction river dashed noisily along its stony bed, confined much of the way on both sides between hills several hundred feet high. We left the granite after a while for hornblende rock and the talcose rock formation, the last prevailing through the latter part of the day. Often the two kinds of rock were closely associated or intermingled as if parts of the same formation, the pearly talcose slate occurring in the same ledge with hornblende slate. The talcose varieties were often compact and broke into angular fragments. The schistose structure when apparent, and the principal fractures, were nearly vertical in dip. Occasionally the rock had the color of serpentine, and a variegated appearance like verd-antique marble; then again it was pale copper-blue or light green, in color. It passed also into a hypersthene rock, somewhat schistose, containing pearly plates of hypersthene. At two places we observed broad dikes of porphyritic basalt, with a corresponding change in the soil.

October 6.—Through the day, ascending and descending the mountains that enclose the valley of Destruction river. It was not unfrequent that a pack-horse, upon a steep ascent, fell over backward and rolled down hill with his load: yet there were no serious accidents. The horse tried his legs again with better success for his experience. At noon we climbed a steep ridge to a height of 800 feet, and then began an immediate descent to a still greater depth. The rock thus far (excepting some dikes of porphyritic basalt) had been talcose, and a dark blue-black argillite with a talcose lustre; the latter was thin fissile, and though

often contorted, the cleavage was generally vertical, or nearly so. But at this ridge we came upon a coarse sandstone and fine siliceous conglomerate, extremely hard and compact. It had a light color, and the rounded pebbles were mostly white, though at times black. Beyond, we found again porphyritic basalt. The hills for the last two hours of the day were more bare than usual, being covered usually with shrubbery and but few trees. We encamped on the upper prairie of the river, a fine grassy flat shaded by a few pines.

October 7.—The sickness of two of our number detained us at our encampment through the day. The rocks along the stream were a blue argillite and compact sandstone, which dipped to the northeast (compass course) about 60°. Some of it was a grayish green rock breaking into regular fragments, and slightly glistening with minute scales of mica. No fossils were observed. Across the stream, the sandstone and argillite formed a precipice of 70 feet; it was horizontally stratified, and very much fissured in various directions. The sandstone is an extremely hard compact rock, in which it is difficult to distinguish minute quartzose grains even with a lens.

The boulders along the stream consisted mostly of the hypersthene rock, of grayish, greenish and brownish colors, and pearly with hypersthene, along with masses of syenite and hornblende rock, some of hornblendic gneiss and granite, and others of puddingstone and basalt.

October 8.—Soon after leaving our encampment on our way down the stream, we found the sandstone passing into a conglomerate. We travelled over an undulating and hilly country, avoiding a mountain of 2000 feet which we left between us and the river, forded the stream three times in the course of the day, and finally encamped again near its banks, on a fine meadow, under a shade of oaks. The whole distance with small exceptions was very rocky. Along the bottom of the valley, the rocks stood up in ledges, ragged points and rude hillocks; and during freshets the river must present a scene of frightful grandeur. These rocks consisted of puddingstone alternating with slate and sandstone, and dipping from 30 to 60°, yet often vertical. At our second ford, the strata were inclined 65° to the northwest and west-northwest, (compass course,) and near by became vertical; they consisted of both shale and puddingstone. The latter was a very hard rock, made up of rounded siliceous pebbles, many like flint and various in their colors. The rock might make good millstones. The slates were fine grained, and neatly fissile, splitting into thin plates. Quartz veins and seams were numerous.

October 9.—Continued down the valley, over hills and ridges, mostly an arid country with little grass and only scattered pines and oaks. The stream was enclosed between bare rocks on

either side, which were extremely rugged and broken. Talcose rocks prevailed along the route ; they were sometimes thin slaty, and often compact. The latter passed into a compact rock of a bluish-green or grayish-green color, giving a light greenish tint to the water, when forming the bed of the river. The river was still a rapid stream ; it was about eighty yards wide, and averaged four feet in depth. The rocks stood up in jagged points, and the hill-sides were covered with angular fragments. One hill consisted of protogine, a granite-like rock composed of feldspar, quartz and dark olive-green talc, in rather coarse grains, and containing some spots of compact talcose rock. It was nearly white in color, and much disposed to crumble.

October 10.—After three hours' travelling, the last hour over an undulating region densely strewed with pebbles, among which few blades of grass found place, we reached the summit of a terraced slope sixty feet high, and looked over the wide plains of the Sacramento. This terrace was visible far southward; and also to the northward and eastward it formed a distinct border to the river flats. The distance to the river was estimated at about 1200 yards. After passing 700 yards there was a second descent of six feet, and 400 yards beyond another of eight feet : 100 feet from the last the river was running along beneath banks twelve feet high. We soon after found that the eight feet of the last terrace belonged properly to the river banks, twenty feet being their prevailing height. It was an example of a plain formed by the wearing action of the river floods below the usual height of the bottom land, and served as a caution against considering every terrace observed as proof of a distinct change of level. The soil of the lower prairie was rather pebbly.

We encamped on the banks of the river, and soon were visited by numbers of Indians. They had thick bushy hair, descending low on the forehead; in some it was parted along the ridge of the head, and hung down on the shoulders, while in others it was divided either side, and that of the top from the forehead to just back of the crown was collected together and tied with a string of deer-skin. A loop of the same kind, sometimes with a bead upon it, and about two inches long, was tied in the ear. The Indians were mostly quite naked. A few had a deer-skin, raw or dressed, thrown over one shoulder, or tied around the loins. Their faces were usually painted with black or brownish red paint; some with the forehead black, and a black triangle covering nearly all of each cheek, one angle being at the mouth; others had the ochre put on in zigzag lines over the forehead and cheeks, or in spots with zigzag margins. The women had the lower part of the face, below the line of the mouth, tattooed. The features were more regular than with the Chinooks of the Columbia river ; the cheek bones but moderately prominent ; the

nose but little enlarged and hardly flattened; the mouth large; the length of the face well-proportioned to the breadth. They were full of jest and merriment; and it was difficult to obtain any words of their language, as they would soon begin to laugh when questioned, and refuse to reply—thinking it, apparently, all a joke. They valued beads, tobacco, and knives, but refused blankets, and cared nothing for powder.

This camp was situated about 160 miles in a direct line from Sutter's, near latitude $40\frac{3}{4}°$ N., or about 120 miles above the Bute.

October 11.—Soon after leaving camp, we ascended a terrace of twenty feet, and half a mile beyond reached the upper prairie, here reduced to a collection of hills, of nearly uniform height, and showing sides of stratified earth and gravel, rather firmly compacted. The streams and rills of the rainy season, had carried on the process of excavation and removal, until the former plain was only traceable in the uniform height of the hills. Large streams (dry when passed by us) had made valleys 300 feet in width, which were strewed with loose rounded stone. The surface of the region was nothing but gravel and coarse pebbles, and proved extremely hard travelling for the horses. After a while the hills became wider undulations, yet the character of the country was the same; the whole was arid, but bore some shrubbery and scattered oaks. This region fronts the bottom land of the Sacramento with slopes from 60 to 100 feet in height, and gradually rises in the course of a few miles back, to 150 or 200 feet. It is properly the upper terrace of the valley.

The pebbles were mostly siliceous, many of red jasper, intersected by veins of quartz, and others of milky quartz or fragments of the talcose rock formation. There were a few of porphyritic basalt and puddingstone. After fifteen miles over the pebbly hills, we descended to the lower flats, and encamped near the Sacramento, a noble stream 100 yards or more wide, flowing placidly along between thinly wooded banks. This lower plain proved to be fine soil, though dry from the summer's drought, and mostly burnt over. The stones of the prairies were generally varnished with a pyroligneous oil arising from the burning of the grass. This oil had a smoky and acrid taste.

October 12.—Just below the encampment, the upper prairie bordered the river with a perpendicular bluff of 100 feet. We ascended it, and for four miles travelled over its gravelly undulating surface, occasionally descending into its intersecting valleys. At one place we found one terrace of thirty-five feet—a second, 300 yards beyond, of twenty-five feet, and 200 yards beyond this lay the river, between its banks of twenty feet. The lower plain was mostly a light-colored loam of sandy appearance, in this, the dry season.

After two hours, we forded the Sacramento in three feet water, and encamped on the eastern prairie, at what is called the Bear Camp, near the parallel of 40° N. The prairie was in part gravelly, but probably produces abundantly in the wet season. In the course of the evening, five grisly bears were killed. Deer were running through the camp in every direction, and many herds of antelope were seen. Wolves at night kept up a perpetual howl, and one came and carried off from alongside of our tents the skin of a bear. Bear stewed, bear roasted, and dough fried in bear grease, composed our evening meal.

October 13.—Travelled south over the lower prairies east of the Sacramento, which are four or five miles wide on this side, and found the soil fertile, except when we approached the margin of the *upper* prairie, where the country proved to be pebbly like the same region on the opposite side of the river. This upper prairie stretched along at an even height, not far from sixty feet above the lower plain. Some few pebbly spots were passed on the lower prairie. The pebbles were partly siliceous, like those seen on the eastern prairie hills, and like them indicated that the talcose rock formation was still prevalent in the mountains. There were also numerous pebbles of cellular lava.

The alluvial soil was in some places of a black color, and deeply cracked by drying, the cracks opening three inches and two feet deep. This fine country like the Willammet plains was covered with oaks,—the trees averaging about twenty to an acre. The common species bears a long spindle-shaped acorn which was food for both bears and Indians, the latter making it into a black loaf by roasting and pounding.

October 14.—The day was passed in travelling south along the lower prairie—a region of good alluvial soil, often black and deeply cracked; it appeared probable that during the freshets the whole was under water. There were scattered oaks as usual except for two or three miles. The upper prairie appeared to be six or eight miles distant to the east. In the west the plains were without apparent limits; but according to Mr. Wharfield, they extend about eight miles beyond the river. This makes the bottom land of the river in this part (thirty-five miles north of the Bute) fifteen or sixteen miles wide. Large herds of antelope and elk ran before us as we rode over the plains, and deer were often startled and went bounding off among the distant oaks. Encamped on the banks of the Sacramento about thirty miles north of the Bute. Wolves yelling as usual through the night.

October 15.—Journeyed on the lower prairie to Beaver (or Bute) creek and encamped on its banks. The country was perfectly flat, and but thinly covered with grass, and some portions afforded but slender pasturage. In general the soil was good; a considerable portion was a little clayey, and had been baked hard by the sum-

mer's sun. But the rains of the winter season, as with similar soil in the Willammet. would probably develop great fertility.

October 16.—To the south of our encampment there stood in the flat prairie an isolated collection of summits, the highest of which was about 1800 feet. It looked like a detached mountain ridge, much broken into peaks, with long low slopes at either extremity of the range, melting very gradually (at an angle of 5°–8°) into the flat bottom land of the river. This is

Sacramento Bute, bearing southeast-by-east.

the *Sacramento Bute*, called also the *Three Butes*. It was found to be an extinct volcano. The lower slopes are cut off in most parts from the central mountainous portion by a flat valley, three to four hundred yards wide; and they face this valley, or broad highway, with a mural front of one to three hundred feet. In the figure, *na* is a profile view of the lower slope, the belt of the Bute, which in many parts is a mile wide; and at *a* is the precipice bounding the interior valley. There are several openings to the valley through the belt; we entered by one of them on the south, and after travelling seven miles emerged again on the east, and at this eastern entrance encamped near a small pool of standing water.

The form of the Bute is nearly circular, and its diameter is about eight miles; it stands like an island in a vast prairie of millpond smoothness. The inner valley is to a great extent at the same level with the plains without, and during freshets, had evidently been covered by water.

The central peaks are steep and rugged, rising into bold crests at top. The rock is porphyry, or trachytic porphyry. The latter where first seen looked like a coarse syenitic gneiss. The feldspar was in large translucent crystals, and through the base small crystals of hornblende were disseminated. The usual colors were gray, reddish or purplish, and white. Another variety was laminated, and the laminæ were thin and easily separable, at times looking like porcelain. Some specimens were formed of alternations of chalky and compact layers, and one block broken open consisted of delicate stripes of white, light sepia brown, and a bright purple color. This laminated rock contained mica in hexagonal scales.

The Bute was evidently a volcanic cone. It is probable that the centre, at some period in its history, subsided, leaving only the lower part of the slopes entire. As rocks and fragments from ejections are not found over the prairie around, it was extinct before the present river flats were formed; and the overflow of the river has since filled up and levelled off the surrounding country,

as well as a large part of the annular plain. A hill of trachytic blocks near the eastern entrance may have been one of the later points of eruption. As the cone is partly buried in the river detritus, we evidently see only a portion of its original elevation, and it may be but a very small portion.

Upon the lower slopes of the Bute sixty to one hundred feet above the plain, we found again siliceous pebbles like those of the upper prairie, and these pebbles were the only traces of the terrace that were distinguished. They consisted of jasper and quartz, and had evidently originated from the talcose rock formation. There were also some of basalt.

The prairie before reaching the Bute consisted of loose alluvial soil, of a dark color, much cracked; for some distance it broke through at every step, and it was much like travelling over crusted snow. The whole country, we were told, was flooded during the winter freshets, and the deer and antelope of the plains then take to the Bute hills.

October 17.—The flat prairie south appeared to be less productive than on the preceding day, the grass being in straggling tufts, or covering the surface with a light furze. For twenty miles we found no water, and finally reached a line of trees that had long before been pointed out to us as the shore growth of Feather river. After following down the stream about four miles we encamped near its mouth in a grove of oaks. The river was a slow stream about thirty yards wide, with alluvial banks twenty feet high. An antelope was shot during the day, and a fat cow in the evening. Elk, deer and antelope were seen in great numbers.

October 18.—Forded Feather river in three to four feet water. Six hours of hot travelling over a flat prairie brought us to Sutter's settlement on the Sacramento. The soil was less fertile than much that we had passed, and for the last two and a half miles the surface was dry and gravelly or sandy. Other portions however were more productive.

A portion of the party took the river for the bay of San Francisco. At the straits of Caquines, bluffs of soft sandstone alternating with some clayey layers, formed the shores. The sandstone was neatly stratified in layers from four feet to one inch thick, and had a dip of 50° to 70° to the west and southwest, in some places it was vertical; and within two hundred yards it changed to an inclination of 35° or 40°. The faults were numerous. Although no fossils were observed, other characters lead me to refer it to the same formation with the Astoria sandstone, which Mr. Conrad has shown from the fossils to pertain to the miocene period. On a small island near these straits, gypsum is found in thick seams.

This sandstone is easily worked, and some layers will make a good building material. The Sacramento Bute, though distant from the settlements, must become more valuable for its stone quarries, the material being both durable and of handsome appearance.

North of the Bay of San Francisco, just east of Sausilito, we again found talcose slate of various colors, and also hills of red and yellow jasper in layers. The layers averaged two inches in thickness, but varied from half an inch to four inches. The talcose slate at one place, approached steatite in character and contained actinolite and nodules of an impure serpentine. Some fragments appearing like fossils were found in these rocks, but they were afterwards lost.

The region of the Sacramento is remarkable for the great extent of its alluvial flats. Two hundred miles from its mouth they are twenty miles wide, and near Sutter's, we were informed that the width was fifty or sixty miles. In the season of our journey, there was no green grass to be seen, except immediately along the water; the whole surface was dry, and the grass remained as standing hay for the cattle. The rains had not yet begun. They are generally delayed till the latter part of November, when they set in for the winter and occur at frequent intervals until the middle of March. The country about Sutter's is then mostly under water, and the same is the fate, as we were told, of a large part of the bottom-land of the river.

The distinct outline of the terrace between the upper and lower prairie is another marked feature of the region. This terrace is mostly about sixty feet high; but the plain above gradually rises to 150 or 200 feet. Its pebbly features were retained both east and west of the river, and also in the mere traces of it on the Sacramento Bute. This volcano, therefore, since it became extinct, has been washed by waters sixty feet or more above its present base.

The prevalence of talcose rocks over the route travelled is a striking fact. They abounded in the Shasty mountains, along the head-waters of the Sacramento in that region; and the pebbles of the upper prairie indicated their continuation far south. Moreover, we again met with them adjoining the Bay of San Francisco.

We had found the same rocks on the route farther north, south of the Umpqua river, and in the Umpqua mountains, an east and west range, just south of latitude 43°; and in some places they abounded in quartz veins. Their peculiar features in the Umpqua region, and also in the Shasty mountains about the Sacramento waters, as well as in pebbles farther south, led to the following statement in my Report, written soon after leaving the

country: "The talcose and allied rocks of the Umpqua and Shasty districts resemble in many parts the gold-bearing rocks of other regions; but the gold, if any there be, remains to be discovered."* The term Shasty district, here used, did not include the region of the Shasty Indians north of the mountains, (to which it is now properly restricted,) where the rocks were not found, but the Sacramento district where entered upon among the Shasty mountains: and although I was not warranted in giving the specific statement a wider scope, from finding only pebbles farther south, my opinion actually embraced the whole range of country. The same opinion would have been arrived at by any geologist at all acquainted with the modes of occurrence of gold. It is also quite probable, from indications observed by the writer, that gold may be found in many parts of the range of country between the Umpqua and Sacramento. The fact that this metal is often associated with talcose rocks was first stated as a general principle by Prof. Amos Eaton.† It is also well known that gold occurs in clay slate, mica and chloritic slate, as well as talcose slate, and but rarely in granite.

The writer was not over the region of the Sacramento mines, the route of the party being on the alluvial flats not far from the river. Moreover, the journey was necessarily as rapid as could be accomplished, since our time was limited, and the limits fixed were unavoidably exceeded. Besides, the Expedition, which had already been at sea longer than the time appointed on leaving the country, was upon the point of starting from San Francisco on its return. Less than four weeks were spent in travelling from latitude 42° south, a distance of 400 miles by our route, which is obviously a small allowance of time for developing the mineral resources of so large a country. It was but a hasty coup-d'œil, to be afterwards filled up in its details by others.

Appendix.—As there is much misapprehension among those interested in the gold of the west, respecting its modes of occurrence, a few words are added upon this subject. Many think to find the sands glittering with gold dust, and others in exploring the mountains hope to lay open rich massy veins of the precious metal, like those of ordinary ores.

The slate rocks alluded to—(compact, slightly glistening, slaty rocks, of various dark colors, the talcose more or less greasy in look or feel, and often greenish, and the chloritic mostly of a darker olive-green color)—contain often veins or beds of quartz, and in this quartz, (and often the rock immediately adjoining,) the gold is found;—not forming continuous lines of metal, but

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* This sentence has been misquoted in the papers.

† See this Journal, vol. xviii, p. 50.

disseminated in grains, scales, delicate leaves or thin plates, irregular strings, and sometimes in rude lumps. The quartz being an extremely hard mineral, is quarried out with much labor. A large part of it may not show a grain of gold to the naked eye, and still by pounding, washing, and amalgamation, a considerable quantity may be obtained. Masses of quartz at the Moss mine, Virginia, examined during a visit of Prof. Silliman, yielded five to eight dollars of gold to the bushel of rock; yet no gold was previously detected, although examined by a magnifier.* In better parts of the vein, grains or strings of the metal may be at times visible, and very rarely a lump of a few ounces, or perhaps pounds, is encountered. The largest mass of gold from the Russian mines was found in 1842, in Taschku Targanka; it weighed nearly 100 troy pounds.

The quartz is generally cellular, and sometimes tabular in structure. Iron pyrites is often present; and this mineral may contain gold in extremely delicate leaves. Galena or lead ore, and several other minerals, may also occur in the quartz. Magnetic iron is frequently found in the same region, and occurs as iron-sand in the soil; it is abundant in some of the Russian gold regions.

In the search for veins of gold, the most that can be hoped for, is the discovery of *quartz* in large veins or beds, which by dint of hard quarrying, the working of heavy stamping mills, and careful amalgamation will yield its produce, large or small as the case may be.

Alluvial washings, the world over, have been the principal sources of the precious metal. Among the Russian mines (which in 1846 yielded over $16,000,000) the rock is mined only at Ekaterinburg. The sand or gravel of a gold district, as that of California, is the rock ready pulverized by natural causes (wear from abrasion and decomposition); and it is thus made ready for the farther operations of the miner. The streams of water washing over this soil, still farther aid in the preparation, by collecting the gold into the bottoms of valleys and carrying off the light gravel and sand (these being seven times lighter than the gold), thus leaving the grains of metal along the beds of the streams and the bottoms of ravines.

Auriferous sands or gravel seldom contain the gold in grains that are visible without a farther careful washing by the miner; and often little then becomes apparent, until mercury is added and the process of amalgamation carried through.

The region covered by the debris of the California mountains is as wide as the vast prairies of its long-reaching rivers, and the slopes that rise into the ranges on either side. The gravel of

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* This Journal, xxxii, 105, 106—1837.

these slopes and the stratified earth and gravel of the plains may therefore contain gold. But the parts more nearly in the vicinity of the particular gold-bearing rocks, naturally prove most productive; moreover, different layers in the soil, where they are a result of successive distribution, may differ widely in their yield. Again, as above stated, the gold will be collected most largely where the streams running through the earth or gravel have performed to some extent the washing process, the gold settling while the gravel is removed.

On the east, stands the Sierra Nevada, covered largely with snows, a perpetual source of water for streams. Consequently, the Sacramento receives from this side numerous tributaries, and into these tributaries a large number of rivulets flow along the ravines, and into the rivulets numberless rills from the hill sides. The last mentioned, from their steepness, carry the earth and whatever it contains into the ravines; the rivulets, also steep, leave along their bottoms part of the gold, but carry on another large part and much earth; while the large tributaries transport principally gravel and earth, leaving the gold to settle most abundantly towards their upper parts, though distributing the finer grains along their whole course. The American Fork, (emptying near Sutter's, about ninety miles from the sea,) Feather river with its many affluents (entering twenty miles further north), and other streams, from their sources in the mountains, have long been engaged in this washing process. Every winter's rains carry forward the process anew, on a scale of great magnitude, and will hereafter replace to some extent, what may be carried off in the other months of the year.

The Sacramento receives few tributaries from the west; for the coast mountains are not over 5000 feet in height, and the little moisture they condense in summer flows down the western slopes of the ridges. There are however some dry beds coursing through the plains that are generally filled in the rainy season.

The valley of the San Joaquin is a repetition, in nearly every feature, of the Sacramento. The two properly constitute one single north and south valley, 400 miles long, enclosed between the Sierra Nevada and the Coast Range.

The occurrence of alluvial gold commonly in flattened grains arises directly from the forms it has in the rocks, and partly from the wear and tear to which the whole is subjected. The abrading and battering action of the moving waters and gravel, besides setting loose the disseminated particles of gold, tends to reduce the leaves or laminæ to scales, breaks up the strings of metal to fragments, and wears off the rough exterior of the larger lumps.

Art. XXVI.—*Some remarks on the Navicula Spencerii, and on a still more difficult test object;* by J. W. Bailey.

I have learned from several quarters, that the notice of the new test object to which I gave the name Navicula Spencerii contained in Quekett's Practical Treatise on the Microscope recently published, has given rise to most erroneous impressions which justice to all concerned requires me to correct as far as is in my power. The work alluded to has not yet reached me, but I am indebted to a friend for the 8th and 9th plates, and the following extract referring to the test in question.

Navicula Spencerii.—Early in the present year, Mr. Matthew Marshall received some specimens of this species from Professor Bailey, of West Point, New York, who stated that an object-glass, constructed by a young artist of the name of Spencer, living in the back woods, had shown three sets of lines on it, when other glasses of equal power, made by the first English opticans, had entirely failed to define them. Mr. Marshall was supplied with the identical specimens on which Mr. Spencer's object-glass had been tried; these have since been carefully examined by Mr. Marshall and Mr. Warren De La Rue, and the nature of the markings clearly made out. Mr. De La Rue, has obligingly furnished the author with Plate IX, in which he has faithfully delineated a specimen of N. Spencerii, as viewed under a power of 800 diameters, and a portion of the same magnified 1,900 diameters, from which it will be plainly seen that the lines discovered by Mr. Spencer are in reality dots, and arranged so as to exhibit both transverse, longitudinal, and even oblique striæ, when viewed by an object-glass not capable of separating the dots one from the other. Mr. De La Rue has further made out that the dots are not projections from the surface, but are either perforations or depressions. The shape of the shell is not unlike that of a small kind of N. Hippocampus, which the markings also very much resemble.—p. 440.

The above notice is accompanied by a plate drawn by Mr. W. De La Rue representing the object as seen by him, magnified 800 diameters, and a figure of a portion of the same magnified 1900 diameters is also given to show the supposed perforations.

I believe the impressions which have been generally received by American microscopists, on the perusal of the above, are that it indirectly charges me 1st with underrating the English microscopes; 2d with over-rating both the merits of our own artist Spencer, and the difficulties of the N. Spencerii as a test object, and lastly, that the structure, or markings upon it, have been wholly mistaken both by Spencer and myself in consequence of our working with glasses "not capable" of properly resolving the object in question, and hence greatly inferior to those made in London. A few remarks upon each of these points will I trust suffice to correct these errors. To the excellence of the lenses made by Ross and Powell of London, I have always given most willing testimony, and in the only allusion which I have

ever made to them in print, I mentioned their superiority to any European glasses which I had seen, and I only claimed for Spencer that, judging from memory alone, his lenses showed me all that I had previously been able to see on the Navicula Hippocampus by the best English achromatic combinations. I made this statement at the very time when I knew that some of the best English microscopes in the country had failed in the hands of their owners, to resolve the N. Spencerii which Spencer has mastered; and I did not claim superiority for Spencer's lenses, as I fully believed that these British microscopes would also easily resolve the lines in question, if the peculiar management of light which they require was once hit upon. The correctness of this belief was shown by the first trials which I made with two London microscopes, one made by Ross and the other by Powell, and which was brought to West Point by their owners for the express purpose of trying them upon the N. Spencerii, an object which had hitherto baffled their endeavors to resolve it. It was prior to these trials that the letter sent to London "early in the year" was written, in which I stated that the English instruments in the country had failed to resolve the new test, and I feel very confident that in making this statement, I mentioned that up to that time I had not tried the English lenses on this object myself, and also stated the belief I always entertained, that they would resolve it by the aid of proper illumination.

It was certainly not so late in the year as the publication of Mr. Quekett's volume, when I informed the London artists through Mr. Marshall, that by aid of their instruments I had satisfactorily resolved both the longitudinal and transverse lines upon the object, on the first occasion when I had an opportunity of trying their lenses upon it. As I feel sure that the leading London artists will acquit me of all intention to underrate them, I will pass from this subject to the easy task of showing that I had not overrated Spencer's merits, nor the difficulty of the test object which bears his name and which he first resolved. Upon these points I will cite from original documents. Let us see whether the Londoners did not find *their* best instruments apparently incapable of mastering the object which our American back-woodsman had so successfully managed. The first letter which I received from London, informing me of the reception of mounted specimens of the N. Spencerii which I sent over to my friends in London, is dated May 20, 1848, and contains the following remark in which I have italicised the acknowledgments so frankly and honorably made.

"The evening I received your package there happened to be a small gathering of our microscopic friends. Your slide with the Navicula Spencerii underwent a long examination. *We how-*

ever could make nothing of it. * * * We had some of the finest glasses of Smith, Ross and Powell in our examination, and I am bound to state that at present the result is most unsatisfactory." A postscript to the same letter says, "Since the above was written, I have made several efforts to get at the markings on the N. Spencerii, but without success." A subsequent letter dated June 2d, 1848, says, "Still however, I can make nothing of your N. Spencerii, although I have employed one of Powell's best glasses with the power of at least 1100."

Knowing by my own experience that the difficulty which my London friends met with, was due to their not employing the much greater obliquity of light which this object requires than any other test previously known, I again wrote to London and sent particular directions concerning the mode of illumination used by Spencer and myself, at the same time expressing my belief that, (as was really the case,) before my letter could reach London the difficulty would be overcome. A letter received by me about the time, from Manchester, England, dated July 27, 1848, is as frank in its acknowledgment of the difficulty of resolving the N. Spencerii, as those from London above alluded to. It says, "You have indeed fixed us all now; D——, and myself have given the thing up in despair, and must confess ourselves thoroughly beaten by your Yankee back-woodsman."

The next letter from London announced, as I expected it would, the success of the London microscopists in resolving the test. It is dated July 28, 1848, and says, "I have had an opportunity of submitting your specimens to a very careful examination by the best glasses of Ross, Powell and Smith, our three best makers, and by oblique light we are enabled to resolve them most unmistakeably. But all our efforts to detect the markings by direct light proved fruitless."

From what precedes it appears that from the 2d of May to some time in July, the Navicula Spencerii remained in London and not a line, much less dots or perforations, could be seen upon it, although Spencer had resolved two sets of lines upon it by means of his lenses, mounted as he informs me in a *hand tube* and without the aid of achromatic condensors, adjusting screws or even a stage to support the glass slide. a feat, by the way, of the practicability of which I have convinced myself, but which is unparalleled in the history of optics.

It would be unjust to our English friends, if I did not now proceed to show what they developed upon the test in their subsequent trials. And it will presently be shown that Spencer has at least kept pace with them without any previous knowledge of their progress. A letter from London, dated August 18, 1848, says, "the N. Spencerii is certainly the most trying test I have yet met with. * * * I have resolved the cross lines upon it *mounted in*

balsam, without any particular management of light beyond what is attainable by the ordinary reflection. By the aid of Ross's $\frac{1}{12}$th we have unmistakeably brought out these markings on an object mounted dry, and by direct light through the achromatic condensor, and moreover resolved these lines into dots or granulations. I am prepared to say that should you be able to effect this, it will at once stamp Spencer as one of the first makers either in the old or new world. I ought however to observe here, that I think that ere long I shall be enabled to report the resolution of these markings by direct light even in the object mounted in balsam, having pretty nearly accomplished it in the last trial with a friend."

As Spencer long ago demonstrated the existence of both the longitudinal and transverse lines, it followed of course that if both sets could be seen at once, the surface would appear broken into little squares or granulations, precisely as in the much larger and easier test the N. Hippocampus. The resolution of these tests mounted *dry* is so much easier than when in balsam, that objects thus mounted are of little value in testing the powers of lenses, although they may answer well when the end is to make out the real structure of the object itself.

I proceed now to notice a discrepancy between Mr. De la Rue's measurements and my own, and to remark upon the existence of the depressions or perforations which he claims to have seen. I have carefully and repeatedly measured by means of Chevalier's camera lucida eye-piece, the distance between the transverse lines or rows of prominences on the adult Navicula Hippocampus, and have invariably found it to be about $\frac{1}{4\,0\,0\,0}$th of an English inch, and both by estimation and the most careful measurement I could make on an object so minute, the corresponding lines on the Navicula Spencerii are, as I stated in this Journal, at least three to five times closer, or from $\frac{1}{1\,2\,0\,0\,0}$ to $\frac{1}{2\,0\,0\,0\,0}$ of an inch apart instead of $\frac{1}{4\,0\,0\,0}$ to $\frac{1}{5\,0\,0\,0}$ as stated by Mr. De la Rue. To decide whether the appearance of lines on the N. Spencerii is due to the allinement of depressions or perforations, or to rows of elevations, or finally to two or more sets of grooves which by their crossing break its surface into granulations, is not an easy task if we confine our attention to so small an object as the N. Spencerii, but there can be no doubt that a perfectly analogous structure exists in all the Naviculaceæ (connected perhaps with their mysterious organs of locomotion), and the real nature of this structure can best be made out by studying the forms which are most coarsely marked, such as some of the species of Rhaphoneis, Sceptroneis, Cocconeis, Stauroneis and the large species of the genus Navicula, such as the N. Baltica and N. Hippocampus. If attention is paid to the direction of the shadows, and the deceptions due to *refracted light* are avoided, I believe that little doubt will be left

upon any mind, that rows of prominences, variously arranged, produce all the appearances of curved or rectilinear striæ seen on these objects, and nothing which I have yet seen on the Navicula Spencerii is at variance with the view.

If the lines seen on this species or upon the N. Hippocampus are due to rows of pits or perforations, I cannot see why they should not appear equally distinct and strongly marked whether viewed in the longitudinal or transverse directions, a fact which is easily explained by referring the appearances to two sets of grooves differing in depth, forming rows of prominences by their crossing each other. Mr. Spencer agrees with me in believing that all the lines on the Naviculaceæ are due to elevations or prominences, and these he states differ very much in form as well as distribution, in different species. I believe these prominences will be found on every species of the Naviculaceæ no matter how small, and that any species on which they cannot be made out will be a reproach to the microscope of the age.

I now proceed to give a few extracts from letters received by me from Mr. Spencer, referring to his first examinations of the N. Spencerii and his subsequent efforts. They appear to me to be of much interest, as illustrating his determination to reach the very first order of excellence, and an unwillingness to rest satisfied with what might justly have been considered splendid success. In his letter to me, dated Dec. 28, 1847, he informs me of his first reception of the N. Spencerii which I had sent to him, telling him that he *must* resolve at least two sets of lines upon it, although I could do nothing with it with my Chevalier lenses. He says, "I find the Navicula is striated, as you suppose, longitudinally and transversely. It required all the means and appliances I could command to resolve it. *But I hope the powers I am now making will tell a different story.*" In several subsequent letters he remarks on this test as being *too easy*, although the most difficult one known; and in a letter, dated August 23, 1848, he says, "I hope we shall soon be able to find a much more difficult object." In a letter, dated Nov. 4, 1848, he remarks on the ease with which the lines could be resolved on the objects mounted dry, and adds, "you have done more than I expected your objective would enable you to do, in resolving both systems of lines at once. *My late lenses will do this readily on all the sperimens I have tried.* With a $\frac{1}{5}$ nearly completed, I observe the cross lines by central light by my hand tube, I trust to be able ere long to make out both systems by the same illumination." Finally, under date of Nov. 20, 1848, he announces the discovery of the long desired test object, which should exceed the N. Spencerii in difficulty. He says, "you will remember my calling your attention to a small shell among the infusoria from guano, and that an examination of the species re-

sulted in failure. I have finally mastered it. The same or a similar form occurs among the infusoria from Greenport, Long Island, which you sent me. The shells are beautifully cross lined, *much finer than in the N. Spencerii.* You will find this object worthy to head the list of tests."

The form alluded to is a species of Grammatophora, possibly referable as a *variety* to *G. oceanica*, Ehr., but which I propose to name *G. subtilissima*, on account of its exceedingly minute striæ. It is abundant on our coast, and its markings are so minute that with a glass which readily resolves the Navicula Spencerii mounted in balsam, I cannot detect a trace of lines upon this, and can only satisfy myself of their existence on the specimens mounted dry.

A fuller account of the new test will doubtless soon be furnished by Spencer himself. In the meantime the above hasty notice of it is given, to complete my proof that I have not overrated the powers of our native artist.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On some New Relations of the Diamagnetic Force;* by Prof. Plücker, (Proc. Brit. Assoc. for 1848., Athen., No. 1086.)—Mr. Plücker gave a short account of experiments belonging to a new magnetic action. A crystal with one optical axis being brought between the two poles of a magnet, there will be a repulsive force, going out from each of the poles, and acting upon the optical axis. According to this action, the crystal, if suspended, will take such a position that its optical axis is placed within the equatorial plane. When the crystal has two optical axes, there will be the same action on both; according to which, the line bisecting the acute angle formed by the axis will turn into the equatorial plane. When the crystal is suspended in such a way that it may move freely round any line whatever of the plane, containing both axes, this plane will take the equatorial position. Thus a crystal being neither transparent nor showing any trace of its crystalline structure, we may by means of a magnet find the optical axes. At the same time we get a new proof of the connexion between light and magnetism. When light is passing through a crystal, there are in general two directions, where it is effected in quite a distinct way,—these same directions are acted upon by a magnet.

Prof. Faraday contrived to convert two raw potatoes into representatives of the poles of an electro-magnet, and by a slice of another, with a quill stuck through it, represented the magnetic or diamagnetic crystal with its optic axes—and thus contrived to convey a distinct idea of the results of Prof. Plücker's discoveries of the relations of the op-

tical axes of magnetic and diamagnetic crystals, and the changes of distance to the nature and laws of the attractions and repulsions exhibited under the several circumstances detailed.—Sir W. S. HARRIS considered that the laws of magnetic forces in relation to the action of magnets on each other, or a magnet on a mass of common iron, were liable to vary, from the changes which arose in the amount of inductive action of which the attracting bodies were susceptible. He had shown, in a paper in the *Edinburgh and London Philosophical Transactions*, that in electricity and magnetism the amount of inductive disturbance was limited,—so that after a certain time, under given conditions, the disturbance became the greatest possible, and then the law of the force changed; and hence arose all the irregularities which had embarrassed early inquirers into this subject. In fact, the force between a magnet and a simple mass of iron varied in a simple inverse ratio with the force induced in the iron and with the disturbance conjointly. If either of them became constant, the whole force varied with the other. If, therefore, it should happen that as the disturbance in the iron approached a limit the changes were not uniform, then we obtained irregular results. So long, however, as the induced force went on uniformly, we had the total or absolute force in the inverse ratio of the squares of the distances. In the case of two magnets magnetized, or nearly so, the force of attraction between them varied in the inverse ratio of the simple disturbance, because the amount of the induced force had been reached. On this principle it was found that in the repulsive force between two magnets, the repulsive action at certain distances became changed into attraction; and it is not an uncommon circumstance to find two magnets attract at one distance and repel at another. These results he thought might be applied in explanation of some of the phenomena now under consideration. The force of magnetic action might vary, whilst the diamagnetic force after all may have been constant.

Dr. LLOYD inquired if Plücker had tried whether crystals with positive axes exhibited any difference in the laws of diamagnetic action from those which had negative axes?—Prof. Faraday replied, that Prof. Plücker had minutely investigated this point, and found no diversity of law corresponding to this difference in optical structure. Sir D. Brewster inquired whether Prof. Plücker had investigated the influence which changes of temperature produced in the diamagnetic action of crystals? Some of these changes, he conceived, were of such a nature as to afford an admirable test whether the same circumstances in the corpuscular constitution of the crystal on which their optical characters depended, were those which gave rise to their diamagnetic relations or not. For example, in some of the biaxal crystals, as sulphate of lime, when heated, the axes approached, and at length coincided,—the crystal becoming monaxal; and by continuing the heating, they again separated in a plane at right angles to the one in which they before lay. Such a series of changes, he conceived, if examined in relation to the diamagnetic forces, might afford a test whether the curious properties discovered by Prof. Plücker had their origin in the chemical constitution of the bodies, or in that corpuscular structure from which their optical properties originated. Prof. Plücker replied, that he had not

tried the class of experiments pointed out by Sir D. Brewster; but he admitted their importance, and expressed a determination to pursue the inquiry.—Prof. Grove inquired whether the experiments were tried with the crystals placed in vacuo?—Prof. Plücker replied no; but in every case they were suspended either in air or in water.—Prof. Grove pointed out the necessity of caution in that case, as it was well known that differences between the diamagnetic actions of suspended bodies and of the surrounding medium would sometimes mask and even reverse the action.—Prof. Faraday pointed out the precautions which had been taken to avoid this source of error.

2. *On the Action of the Red, Orange and Yellow Rays upon Iodized and Bromo-iodized Silver Plates, after they have been affected by Daylight, and other Phenomena of Photography;* by M. CLAUDET, (Proc. Brit. Assoc., Athen., No. 1086.)—It was shown by MM. E. Becquerel and Gaudin, that a photographic image on a Daguerrotype plate might be developed by the action of the light which permeates yellow and red glasses, without the aid of mercurial vapor. M. Claudet has been continuing his researches on this point, and he confirms those results in a very striking manner. Numerous specimens were exhibited, in which it was shown that the powers of the so-called *continuating rays* in developing the image were not much inferior to the mercurial vapor —presenting a positive image like it, but differing from it in the tint by which it is suffused. M. Claudet suspects that this result is owing to the decomposition of the iodid and bromo-iodid of silver by the least refrangible rays—and that the whites are represented by finely-divided silver in the place of mercury. The rate of action when the chemical agency permeates these colored media is infinitely reduced for these preparations; but still it is evident that some of the photographic principle permeates them—and also, that these rays which correspond in color with those media have a peculiar scale of action of their own.

3. *On the Influence of Light in preventing Chemical Action;* by Mr. R. HUNT, (Proc. Brit. Assoc., Athen., No. 1086.)—Bearing on the same subject as that brought forward by M. Claudet, although differing inasmuch as one set of experiments were made upon iodized silver plates and the other upon iodized photographic paper, this subject was taken by the Section before any discussion was allowed on the preceding communication. Mr. Hunt having called attention to several experiments in which certain luminous rays had been found to protect photographic agents from chemical change—particularly in the researches of Sir John Herschel,—proceeded to describe his own experimental investigation of this subject. Taking a piece of highly sensitive photographic paper, which would blacken in a few seconds by the light of an argand gas burner, he threw upon it a condensed spectrum which had been previously analyzed by a peculiar yellow medium—and then, by means of a mirror, reflected the strong light of the sun upon the paper. It was, therefore, under the influence of the unaltered reflected radiations—and also of the spectrum, from which the chemical agency had been as nearly as possible separated. The result was, that the paper was blackened over every part except that portion upon which the strong line of spectral light fell, which was protected

from change *and preserved as a white band* in the midst of the darkened paper. This experiment was thought by the author strongly confirmatory of the view which he had taken, that of actinism, or the chemical principle, and light, so far from being identical, are opposed in action to each other.

4. *An Examination of Berkeley's Theory of Vision;* by Sir D. BREWSTER, (Proc. Brit. Assoc., Athen., No. 1087.)—Sir D. BREWSTER's attention was turned to this subject by having been called on to give a course of lectures on the Philosophy of the Senses. He was thus led most minutely to examine the well-known theory of vision by Bishop Berkeley, and made himself minutely acquainted with its details. He found, as he conceived, the fundamental principle, on which the entire theory reposed, defective. Berkeley's first proposition, which contained that principle, was that direct distance from the eye had no linear representative in the image on the retina, and therefore that distance from the eye could not be a direct object of vision: now this first proposition Sir D. Brewster conceived to be false in fact, and therefore the entire theory which was founded on it must be abandoned. That there was a direct linear representative on the retina, even as seen by a single eye, he showed by a diagram to be the result of the rays entering the pupil; and let the pupil be of what size it may, unless reduced to an actual point, which it never can be, it must allow the rays to form an impression of the entire length of a line stretching away directly from the eye, and therefore objects do not appear all at the same distance from the eye, as would follow from the Bishop's theory. But further, Dr. Berkeley founded his entire theory on an assumed fact, which, if true at all, could be so only when one eye was used alone. Man is not an animal with but one eye. An infant obtains his first glances of the external world by opening on it both eyes; and from whatever sources its lessons are derived, both eyes must be admitted to be equally efficient in the knowledge conveyed. In determining this question, he did not consider it essential to decide how single vision with two eyes was effected. It might be from the images falling on corresponding points of the retina,—an opinion now exploded; or from the decussation of the filaments of the optic nerve,—an opinion also exploded; or it might be the necessary result of the line of visible direction—as it certainly was. But wheresoever it originated, it was a fact which must be admitted. They had therefore to determine at what distance, and in what direction, a body would be seen by two eyes when seen single; a determination greatly facilitated by that beautiful instrument the stereoscope of his friend Professor Wheatstone.—Sir David then, by reference to diagrams, explained how this determination was aided by the use of both eyes; and in confirmation of his views appealed to facts recorded by naturalists, to prove that the young of animals saw distances correctly almost at the instant of their birth. The duckling ran to the water almost as soon as it broke the shell. The young Boa constrictor would involve and bite an object presented to it; and in like manner no person ever saw a child use such motions as proved it to perceive objects at its eye, to grasp at the sun or moon or other inaccessible object, but quite the contrary. He also con-

tended that the recorded cases of persons restored to sight by being couched for cataract, or having a pupil formed, led to a similar conclusion;—all of whom saw objects at a distance from the eye, and none supposed those objects to be upon the eye or within it.

Dr. WHEWELL, after expressing his strong sense of the general value and ingenuity of Sir D. Brewster's views, and his diligence of research, begged most respectfully to differ from him entirely in his conclusions. All the facts adduced by him were as well known to Berkeley, and to those who adopted and carried forward his views, as they were to Sir D. Brewster; and he could scarcely suppose that conclusions so firmly based upon facts, and harmonizing so completely with all that was known, would be overturned in a moment by a few well-turned sentences or ingenious popular deductions. As to those animals who were under the dominion of instinct, the question how they at first were aided by their senses, since it was most intricate, he conceived we could not hope to dispose of in this summary manner; and many doubted whether it was not so mysterious in its operations as to leave the question of its final solution at any future period most doubtful. But as to man, he had little doubt that the most convincing proofs could be adduced that he required experience to guide him in the uses to which, at least in mature life, he applied his senses; although he admitted that in infancy something resembling the instinct of other animals was to be observed. But if Sir D. Brewster had persuaded himself that infants, or even persons restored to sight at a mature age, could see the distances and directions of objects directly without any aid from experience, all he could assure him was, that there were many others fully capable of forming a sound judgment who after the most patient and attentive consideration of facts had arrived at a very different conclusion.—Mr. ESTIN, surgeon and oculist of Bristol, must beg to confirm the views enforced by Dr. Whewell. He gave several instances of persons whom he had restored to sight from total blindness, who previous to experience could form no idea whatever of the distances or directions or shapes of bodies; and in one instance the patient for a length of time was in the habit of shutting the eyes entirely and feeling the objects, in order to get rid of the confusion which this circumstance gave rise to. But as her experience grew more perfect, she saw with increasing correctness and pleasure, until at length her sight became perfect.

5. *On the Peculiar Cooling Effects of Hydrogen and its Compounds in Cases of Voltaic Ignition;* by W. R. GROVE, Esq., (Proc. Brit. Assoc., Athen., No. 1086.)—This communication was illustrated by an experiment, in which it was shown that a platinum wire, rendered incandescent by a voltaic current, was cooled far below the point of incandescence when immersed in an atmosphere of hydrogen gas. This remarkable cooling property of hydrogen, of course, became the subject of experimental examination in comparison with other gaseous media. By a very ingenious arrangement, tubes containing coils of platinum wire were filled with hydrogen and other gases, and then being plunged into water in which delicate thermometers were placed, the wires were traversed by the same current from the battery, and it was found that the water was always more heated in a given time by the

wire in the tubes of oxygen, nitrogen, carbonic acid, carburetted hydrogen, &c., than by that in the tube containing pure hydrogen. It became necessary now to ascertain the cause of this peculiar phenomenon of hydrogen. It was found not be due to specific heat, nor to the conducting powers of the gases. Convection did not explain the fact; considerable difficulty was found upon examination if it was attempted to refer it to the greater mobility of the particles of hydrogen gas, the lightest known. It was found that this peculiar property also belonged, but to a less extent, to all the compounds of hydrogen and carbon.

A discussion followed, in which Dr. Williams, Col. York, Prof. Graham, and Mr. Hunt joined.—Prof. GRAHAM mentioned the curious fact observed by him in his researches on the diffusion of gases, that the hydro-carbons move through tubes with great velocity, and that ether vapor, which is four times the density of hydrogen, moves, notwithstanding its weight, at four times the rate of other gases. It was thought this would, perhaps, serve to indicate the path in which an explanation might be looked for.—Mr. HUNT drew attention to the fact, observed by Prof. Graham, that ether vapor had the power of preventing the combustion of phosphuretted hydrogen and of destroying the luminosity of phosphorus, and thought the phenomenon observed by Mr. Grove connected itself in some way with these curious properties of the hydro-carbons.

6. *Report on Coloring Matters;* by Dr. E. SCHUNCK, (Proc. Brit. Assoc., Athen., No. 1086.)—Having referred to the six substances which were discovered in the infusion of madder roots, and described in the last Report, the author announces the discovery of a seventh. The continued investigation of the subject has led to the conclusion, that there is but one coloring matter in madder, *i. e.*, the Alizarin; and that the substance which was thought to be a coloring matter, viz., Rubiacin, is not so. The seven substances found in the brown precipitate from the madder infusion are Alizarin, Rubiacin, Alpha-resin, Beta-resin, Rubian, Pectic Acid and Oxydized Extractive. The examination of the fluid was next made, and found to contain Xanthic acid and madder yellow. It has also been proved that madder contains sugar;—but as the process by which this is separated is somewhat tedious, we must refer chemists to the Report itself. It is known that after madder has been employed for dyeing, it still contains coloring matter, and that the article garanceux is manufactured from this. By treating this substance with boiling muriatic acid, it was found to contains lime, magnesia, oxalate of lime, phosphate of lime, alumina, and peroxyd of iron. After these salts were separated, boiling water extracted a large quantity of coloring matter which would dye mordanted cloth quite full, and of the same color as madder itself, thus showing that it contains alizarin. Alizarin is found to be composed of

Carbon, ...	56·97
Hydrogen, ...	4·19
Oxygen, ...	38·84

—or, in fact, of carbonic acid and water. Alizaric acid is formed by treating alizarin with concentrated per-salts of iron or nitric acid. The salts of this acid are mostly soluble. Alizarate of lime is prepared by

neutralizing alizaric acid with carbonate of lime, and evaporating to crystallization. It crystallizes in prisms possessing great brilliancy. Alizarate of baryta, prepared in the same way by means of carbonate of baryta, cystallizes in silky needles. Alizarate of silver, prepared by double decomposition, is soluble in boiling water, from which it crystallizes as the solution cools. Alizarate of lead is insoluble. By subjecting alizaric acid to heat, it is volatilized, and forms a sublimate in the shape of long white needles, to which the name of pyro-alizaric acid is given. By the solution in water, pyro-alizaric acid appears to be again converted into alizaric acid. Rubiacin was found to be C_{31}, H_9, O_{10}, and Rubiacic Acid C_{31}, H_9, O_{16}. Alpha and Beta resin were next examined, as were also the other constituents: and the author then proceeded to examine the part which each material plays in the process of dyeing: from which it is satisfactorily proved that alizarin is the substance producing the color; and the advantages of converting madder into garancin consists in removing the resins and those bodies which are not only useless but injurious, and in separating alizarin from those salts with which it is in the madder root in close combination.

7. *On the Alloys of Tungsten with Copper and other Metals*; by Dr. Percy, (Proc. Brit. Ass., Athen., No. 1086.)—Since the introduction of some processes by which tungsten has been separated from its ores, and from its combination with tin and other metals in nature, numerous experiments have been made with the hope of employing it usefully. From the peculiar nature of tungsten it has been thought that it would have the property of giving greater hardness to the metals with which it might be alloyed, and also of protecting them from oxydation. It was with this hope that Dr. Percy made an extensive series of experiments,—alloying copper, brass, German silver, and other metallic bodies with tungsten. In no case, however, has the result been of a satisfactory character.

8. *Analysis of Wrought Iron produced by Cementation from Cast Iron*; by Prof. Miller, (Proc. Brit. Assoc., Athen., No. 1086.)—It is to be noticed that considerable change in the specific gravity occurred in the iron after cementation: it was forged, and then found to have increased in density; the brittle iron had a specific gravity of 7·684, the malleable 7·718. The results of analysis were briefly these:—the quantity both of carbon and silicon are materially diminished by the cementation, though still the proportion of both is materially greater than in good bar iron. It also appears that the portion of carbon which is insoluble in acids is partly the same both before and after the iron has been rendered malleable, the diminution being confined almost to that portion of carbon which was chemically combined with the metal, and which, therefore, would be in a state for propagation through the mass more readily by cementation.

9. *Gutta Percha*, (Proc. Brit. Assoc., Athen., No. 1086.)—Mr. Whishaw read a paper giving an explanation of the various applications of gutta percha; numerous specimens of which, in the shape of thread, cord, tubular staves, driving bands, constables' staves, sticks, whips, inkstands, medallions, shields, water buckets, stereotype plates, and almost every other description of article, both useful and ornamen-

tal, were present. The paper, after stating that gutta percha was the concrete juice of a large tree of the same name, abounding in Borneo, &c., obtained by tapping the tree periodically by the Malays, stated that its introduction into this country was purely accidental; Dr. Montgomery having transmitted the first sample of it to the Society of Arts in 1843, at which time he (Mr. Whishaw) was secretary to that Society. The first articles of use made of gutta percha in this country were laid before the Society of Arts in 1844, and consisted of a lathe-band, a short length of pipe, and a bottle-case, which he had himself made by hand, having caused the concrete substance to become sufficiently plastic by immersing it in hot water. He also produced casts from medals, which attracted considerable attention at the time, and surgical instruments were soon after made of this new material. It was also adapted to commercial uses; and from the period mentioned to July 11th in the present year, between six hundred and seven hundred tons had been imported for the Gutta Percha Company. From twenty to sixty tons were now regularly imported every month. Contrary to the general opinion that gutta percha is a simple, hydrogenous substance, Mr. Crane (chemist to the Gutta Percha Company) found it in its ordinary state to consist of at least two distinct materials, besides a notable proportion of sulphur—viz., 1. A white matter, gutta percha in its pure state; 2. A substance of dark brown color. Various experiments were made to ascertain its strength when mixed with other matters, and also as to what pigments would mix with it without rendering it brittle or deteriorating its qualities. From these it appeared that the only pigments that could altogether be relied on to be used with gutta percha were orange lead, rose pink, red lead, vermilion, Dutch pink, yellow ochre, and orange chrome. Under the influence of heat and pressure, gutta percha would spread to a certain extent, and more so if mixed with foreign matters. All the mixtures composed of gutta percha and other substances which had been subjected to experiment, except that containing plumbago, were found to increase its power of conducting heat; but in its pure state, gutta percha was an excellent non-conductor of electricity. The best composition for increasing the pliability of gutta percha was that formed in conjunction with caoutchouc tar, and next in order that of its own tar; and the best material at present known for moulding and embodying was obtained by mixing gutta percha with its own tar and lamp-black.

In describing the process of manufacturing gutta percha, the author observed, that rude blocks of the material were first cut into slices, by means of a cutting machine formed of a circular iron plate of about five feet in diameter in which there are three radical slots furnished with as many knives or blades. The blocks are placed in an inclined shoot, so as to present one end to the operation of the cutters. The slices are then placed in a wooden tank, containing hot water, in which they are left to soak until found in a plastic state. They are afterwards passed through a mincing cylinder, similar to that used in paper mills for the conversion of rags into pulp, and then thoroughly cleansed in cold water tanks; the water, in cases of impure gutta percha, being mixed with a solution of common soda or chlorid of lime. It is next put into a masticating machine, such as is used in the manu-

facture of caoutchouc, and then pressed through rollers; thus being converted into sheets of various width and thickness. When necessary, the sheets are again masticated, and again passed through rollers. These sheets are subsequently cut into boards by vertical knives, placed at the farther end of the table, along which the sheets are carried by a cloth or web to another roller, round which they pass, and are cut into the required widths. The bands or straps are then removed, and coiled up ready for use. Driving bands for machinery are thus made, and shoe soles and heels are stamped out of similar sheets of gutta percha.

In making tubes or pipes, either of gutta percha or any of its compounds, a mass of gutta percha, after being thoroughly masticated, is placed in a metal cylinder furnished with a similar piston, by which it is pressed down into an air box, kept hot with steam, which has at its lower end a number of perforations, through which the plastic material is forced into a cup, whence it passes out, round a core, into the desired tubular form, and thence through a gauge to the required size, and into a receiver of cold water, being drawn to the other end of a long trough by a cord passing round a pulley at the far end of the trough, and returning to the person in attendance on the machine, who gradually draws the pipe away from the air machine. Thus tubes of considerable length and diameter are made to a very great extent, and are used for the conveyance of water and other liquids, and are now under test for the conveyance of gas.

The paper next explained the variety of articles already made of gutta percha, which were of three classes—1. Useful; 2. Ornamental; and 3. Useful and Ornamental combined. Various articles were then exhibited, including two very handsome shields, and a splendid Communion Dish and Service.—Mr. Whishaw next exhibited the Telakouphanon, or Speaking Trumpet; and in doing so, said that speaking tubes of gutta percha were quite new, as was also the means of calling attention by them of the person at a distance, which was accomplished by the insertion of a whistle, which, being blown, sounded at the other end quite shrilly. Attention having been thus obtained, you remove the whistle, and by simply whispering, the voice would be conveyed quite audibly for a distance of at least three quarters of a mile, and a conversation kept up. It must be obvious how useful these telegraphs must become in large manufactories; and indeed in private houses they might quite supersede the use of bells, as they are so very cheap, and by branch pipes could be conveyed to different rooms:—and, indeed, if there were no electric telegraphs, they might, by a person stationed at the end of each tube of three quarters of a mile or a mile, be made most speedily to convey intelligence for any distance. In private houses the whistle need not be used, but a more musical sound could be produced.

He then amused the auditors by causing the end of the tube, which was of the length of 100 feet, to be inserted into the mouth-piece of a flute held in a person's hand, regulated the notes, and placing his own mouth to the other end of the tube, 'God save the Queen,' was played at a distance of 100 feet from the person giving the flute breath. Turning to the Bishop of St. Davids, he said that in the event of a clergyman having three livings, he might, *by the aid of three of these*

tubes, preach the same sermon in three different churches at the same time.—Mr. Whishaw also exhibited the gutta percha submarine rope or telegraph; which consisted of a tube perforated with a series of small tubes, for the conveyance of telegraphic wire, and which, for the purpose of preventing its being acted upon by sea water or marine insects was banded or braided round by a small rope, and its being perfectly air-tight, would render it quite impervious to the atmosphere.

10. *Report on the Air and Water of Towns;* by Dr. Smith, (Proc. Brit. Assoc., Athen., No. 1087.)—In commencing his report the author says, it has long been believed that air and water have the most important influence on health,—and superstitions have therefore constantly attached themselves to receptacles of the one and emanations from the other. The town has always been found to differ from the country: this general feeling is a more decisive experiment than any that can be made in a laboratory. The author proceeds to examine all the sources from which the air or water can be contaminated. The various manufactories of large towns, the necessary conditions to which the inhabitants are subjected, and the deteriorating influences of man himself are explained. If air be passed through water a certain amount of the organic matter poured off from the lungs is to be detected in it. By continuing this experiment for three months. Dr. Smith detected sulphuric acid, chlorine, and a substance resembling impure albumen. These substances are constantly being condensed upon cold bodies, and in a warm atmosphere the albuminous matter very soon putrifies and emits disagreeable odors. The changes which this substance undergoes by oxydation, &c., were next examined,—and shown to give rise to carbonic acid, ammonia, sulphuretted hydrogen, and probably other gases. The ammonia generated fortunately from the same sources as the sulphuretted hydrogen, materially modifies its influences. The consequences of the varying pressure of the atmosphere have been observed; and it is shown that the exhalations of sewers, &c., are poured out in abundance from every outlet when the barometric pressure is lowered. By collecting the moisture of a crowded room by means of cold glasses and also dew in the open air, it was found that one was thick, oily, and smelling of perspiration, capable of decomposition and production of animalcules and conferva,—but the dew beautifully clear and limpid. Large quantities of rain-water have frequently been collected and examined by Dr. Smith; and he says, —I am now satisfied that dust really comes down with the purest rain, and that it is simply coal ashes. No doubt this accounts for the quantity of sulphites and chlorids in the rain, and for the soot, which are the chief ingredients. The rain is also often alkaline,—arising probably from the ammonia of burnt coal, which is no doubt a valuable agent for neutralizing the sulphuric acid so often found. The rain-water of Manchester is about 2½° of hardness,—harder, in fact, than the water from the neighboring hills which the town intends to use. This can arise only from the ingredients obtained in the town atmosphere. But the most curious point is the fact that organic matter is never absent, although the rain be continued for whole days. The state of the air is closely connected with that of the water; what the air contains the water may absorb, what the water has dissolved or ab-

sorbed, it may give out to the air. The enormous quantity of impure matter filtering from all parts of a large town into its many natural and artificial outlets, does at first view present us with a terrible picture of our underground sources of water. But when we examine the soil of a town we do not find the state of matters to present that exaggerated character which we might suppose. The sand at the Chelsea Water-works contains only 1·43 per cent. of organic matter after being used for weeks. In 1827, Liebig found nitrates in twelve wells in Giessen, but none in wells two or three hundred yards from the town. Dr. Smith has examined thirty wells in Manchester, and he finds nitrates in them all. Many contained a surprising quantity and were very nauseous. The examination of various wells in the metropolis showed the constant formation of nitric acid; and in many wells an enormous quantity was detected. It was discovered that all organic matter, in filtrating through the soil, was very rapidly oxydized. The presence of the nitrates in the London water prevents the formation of any vegetable matter; no vegetation can be detected, even by a microscope, after a long period. The Thames water has been examined from near its source to the metropolis, and an increasing amount of impurity detected. In the summary to this Report, Dr. Smith states that the pollution of air in crowded rooms is really owing to organic matter and not merely carbonic acid; that all the water of great towns contains organic matter; that water purifies itself from organic matter in various ways, but particularly by converting it into nitrates,—that water can never stand long with advantage unless on a large scale, and should be used when collected or as soon as filtered.

11. *On the Manufacture of Ice.*—Ice at the present day is considered one of the necessaries rather than one of the luxuries of life. Unfortunately those parts of our country where it is most needed are without the means of regular supply. The inland portions of the southern and south-western States, do not get the benefit of the ice trade from the north, the natural ice crop is precarious or altogether wanting, while the heat of summer untempered by the sea breeze makes ice one of the greatest comforts of life.

The manufacture of ice is therefore likely to become a great desideratum and already much has been said on this subject in the papers. It appears that some plan has been devised although no description of the process has been published. As much that is erroneous has been stated, we have thought it worth while to give the results of an actual trial of well known methods.

In France, freezers are used for making ice, ice creams, &c., by the use of several frigorific mixtures, and these freezers are probably to be met with in several of our larger cities. Two different forms have been exposed for sale in the city of New York. The mixtures most recommended for use are crystallized sulphate of soda drenched with muriatic acid, or nitre salammoniac and water. The former of these would in most places be a costly mixture, and while unsafe in careless hands, and destructive to the vessels likely to be used, could not be employed without loss, as it would be impossible to recover the acid when the solution was evaporated. The solution of nitre and salammoniac is liable to none of the objections—the salts are not costly, and

the evaporation can be conducted with very little loss. This is accordingly the process recommended by the inventors of the freezers above mentioned. A Committee of the Society for Encouragement of the Arts at Paris, reported favorably upon the apparatus of M. Goubaud. The salts are not named, but are undoubtedly those above mentioned. To make one pound of ice, about five pounds of the salts with five pints of water were required—the duration of the process fifteen to eighteen minutes. The loss of the salts amounted to not quite one per cent., cost 1·7 cents; the fuel for evaporation, charcoal, at Paris prices, four cents, making the pound of ice cost 5·7 cents or say 6 cents. The chief part of the expense being for the fuel, it is manifest that ice may be made most cheaply where wood or coal costs least. A part of the fuel may be saved by evaporating as far as possible by the heat of the sun; hence the hotter and drier the atmosphere, *cæteris paribus*, the less the cost of the ice.

In the report quoted above, the committee admit that by these and other expedients the cost may be greatly reduced from that named, which it must be remembered is for the city of Paris where fuel is very dear. In most of the southern and southwestern States, the price of fuel is such as to reduce the cost of evaporations to less than one cent for one pound of ice, being in all two and a half to three cents per pound. The loss in the salts could easily be avoided, wholly or in part, and this would reduce the price to less than two cents. But this is not all. The cold liquor resulting from the solution of the salts may be advantageously employed in cooling provisions, &c., and in the contrivances for this purpose, are found the chief difference between the French freezers and those in common use.

It is hardly necessary to state that the widely circulated story that ice can be produced artificially for one dollar per ton, must be an utter absurdity. The naturally formed ice costs at least as much as this by the time it is housed, and that formed artificially must require as much if not more handling.

Sulphate of soda may be added to the mixture of salammoniac and nitre, but we know of no experiments upon its use on the large scale.

G. C. Schaeffer.

12. *Composition of the Tungstates*; by A. Laurent, (Journ. de Pharm. et de Chim., Jan., 1848.)—A study of the properties of these salts has led to the conclusion that they do not all contain the same acid. M. Laurent enumerates five or six of these acids which form ammoniacal salts having different properties, and which when calcined leave an anhydrid having the same per-centage composition, yet are capable each one of regenerating its own acid or ammonia salt.

The first type is the *tungstic** $WO_4\ M_2$ with or without *aq*. To this type belong most of the insoluble tungstates: also the yellow acid $WO_4\ H_2$ obtained by treating wolfram with aqua regia. This acid is very soluble in ammonia, but on evaporation the ammonia salt of the next type is formed.

2d type, *Paratungstate*. This includes most of the common bitungstates; the anhydrid is $W_4\ O_{12}$, as that of the last is WO_3.

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* We retain M. Laurent's notation $M_2\ H_2\ Ka_2$ and being equal to M, H, Ka.

The anhydrated acids are $W_4 O_{14} H_4$; another +2aq.; another +8aq. There is also a number of ammonia and double salts, some of them of great interest, having singular peculiarities in their crystalline forms.

3d type, *Metatungstate.* The action of nitric acid, brings the ammonia salt of the last type into this. This salt forms octahedrons; the acid itself is very soluble. The formula for the type is $W_3 O_{10} M_2$.

The anhydrid obtained at a *dull red heat* produces with ammonia a salt of the next type; the metatungstate of ammonia does the same.

4th type, *Isotungstate.* $W_2 O_7 M_2$; the anhydrid is $W_2 O_6$, and this again is capable with ammonia of reproducing an isotungstate.

5th type, *Polytungstate.* About this there is some uncertainty. The acids $W_6 O_{21} H_6$ and also +2aq. have been analyzed. The anhydrid is $W_6 O_{18}$. There is some probability of the existence of still another type.

These very curious researches are worthy of being followed up, particularly with the ethers which may be formed by their acids.

G. C. S.

13. *On the Crystallization of Sulphur;* by M. S. Pasteur, also by M. Ch. Deville, (Comptes Rend., Jan., 1848.)—M. Pasteur has found sulphur crystallized from its solution in sulphuret of carbon to present the two different forms—the octahedrons usually formed, and also the form obtained by fusion, an oblique rhombic prism—but in this case unmodified.

M. Deville has noticed that the soft red sulphur may be remelted, and cooled either slowly or rapidly without losing its reddish brown color. The prisms obtained by fusion undergo the same changes as to opacity, increase of density, &c., as usual. Still more singular, the solution of this red sulphur in sulphuret of carbon, retains the color, and the crystals formed are in part octahedral, more or less red, by having the colors unequally distributed in part—red prisms changing as usual—and also a portion of amorphous sulphur deeply colored and remaining viscous for a long time. These investigations have a very curious bearing upon the allotropism of sulphur, noticed by Mr. Hunt in a late number, and upon the fact mentioned in the researches of M. Leconte, on the action of sulphuretted hydrogen upon nitric acid*—that the sulphur precipitated without heat, had the soft or elastic condition, commonly obtained by pouring melted sulphur (at a certain temperature) into cold water.

G. C. S.

II. Mineralogy and Geology.

1. *Examination of the Telluret of Bismuth, from Virginia;* by Coleman Fisher, Jr., (in a letter to the Editors, dated Philadelphia, December 26th, 1848.)—In the September number of your Journal, Dr. C. T. Jackson has described a tellurium ore from White Hall mine, Spotsylvania county, Virginia. Having received a small quantity of the ore from Prof. R. S. McCulloh of the U. S. Mint, I subjected it to

* See this Journal for March, 1848, p. 261.

a thorough analysis in the laboratory of Prof. J. C. Booth. I subjoin a description and the analysis.

Description.—Foliated, without any appearance of regular crystallization, the laminæ not elastic. Color between lead gray and steel gray; lustre metallic shining; H.=2; sectile; soils paper slightly.

On charcoal it fuses readily, tinging the flame blue, forms a white coating tinted red on the edge, and gives the odor of selenium. In an open tube, it fuses emitting the odor of selenium, forming a red sublimate of the same, and gives off white fumes, while a fusible yellowish white sublimate of tellurous acid is formed, the residue being brownish white.

Analysis.—It was dissolved in nitro-muriatic acid, evaporated to expel the nitric acid, partially neutralized by ammonia, and precipitated by an excess of sulphydrate of ammonium, with which it was digested to dissolve the tellurium. The latter was determined by solution in acid, and precipitation by sulphurous acid, which was repeated in order to obtain all the tellurium. To separate the selenium from the tellurium, the metal was treated with nitric acid, fused with carbonate of soda and saltpeter, again treated with an excess of nitric acid and precipitated by nitrate of baryta, which throws down seleniate of baryta, insoluble in a nitric solution. The metal can be perfectly isolated, and presented in the metallic state by means of sulphurous acid. The bismuth and iron were separated by sulphuretted hydrogen, and the former determined as oxyd. The silica contained traces of tin, and a minute trace of gold. The following are the results of the analysis of 19·96 grains.

		In 100 parts.	
Bismuth,	10·31	51·65	54·81
Tellurium,	7·14	35·77	37·96
Selenium,	1·36	6·81	7·23
Iron,	0·25	1·25	. .
Silica,	0·77	3·86	. .
	19·83	99·34	100·00

The iron and silica being thrown off as impurities; the per-centage calculation of bismuth, tellurium, and selenium, are contained in the third column. Assuming the oxyd of bismuth as $Bi\ O_3$, when the equivalent of Bi is 213, it is evident that we have a tertelluret of bismuth $Bi\ Te_3$, in which a portion of the tellurium is replaced by selenium: for regarded as $Bi\ Te_3$, the 37·96 of tellurium requires 12·11 bismuth, and 7·23 selenium requires 12·83 bismuth; and 12·11+12·83=54·94 bismuth, which is almost precisely the amount found by analysis. The mineral is therefore similar to the telluret (Tetradymite) found in Hungary, but is a telluret and selenuret, instead of being a telluret and sulphuret. Its approximate formula is $Bi\ Se_3+3\ (Bi\ Te_3)$; or putting the selenium and tellurium together the formula is $Bi\ Te_3$.

2. *Emery Formation of Asia Minor*; by J. Lawrence Smith.—The following communication, received in a letter from Dr. Smith, dated Constantinople, January 5, 1849, is a translation of a communication addressed by him to Elie de Beaumont.

These lines are written with reference to an extract of a letter from M. Pierre de Tchihatcheff, published in the *Comptes Rendus de l'Académie des Sciences*, the 20th of March, 1848. It is only lately that my attention was attracted by this letter, more especially by the last phrase, ("I have communicated all the necessary indications to Mr. Lawrence Smith, American Mineralogist, in the service of the *Porte*, and he proposes *to develope my discovery*,")—because in reading this it would appear that I was entirely ignorant of the existence of the emery alluded to, in Asia Minor, and that the first information given me was by M. Tchihatcheff, on returning from his voyage in December, 1847. I wish in no way to affect his right to the observations upon the Emery which he found between *Eskihissar* and *Melas* in December, 1847—situated more southerly than any of the localities to which my own observations had extended; but I am equally desirous to have my own discoveries attributed to me.

It was in the month of November, 1846, that a merchant in Smyrna showed me specimens of emery said to come from *Kula*, (about eighty miles east of Smyrna.) The importance of this mineral led me early in 1847, to visit Smyrna, for the purpose of investigating this matter. On my second visit to this city, I was shown other specimens coming from the neighborhood of Epheseus, and which being nearer than *Kula*, I at once visited. About twelve miles to the east of Ephesus, near to the village of *Gumuchkeny* and on the summit of *Gumuchdagh*, I discovered emery *in situ;* however, before arriving there I saw this same mineral more or less scattered over the country. The Turkish government, to whom I communicated the importance of this discovery, sent a commission with me to examine the region in the *month of May*, 1847, a fact which was announced *publicly* in the *Journal of Constantinople* the 16*th of May*, 1847, in the following words:—

"It is some time since Monsieur le docteur Smith, American Mineralogist, of whom we have had frequent occasion to speak, discovered at Magnesia, near to Gumuchkeny, an *emery mine*, and of which he brought specimens to Constantinople. The government has sent to the place a commission composed of Dr. Smith and some of the officers of the Imperial powder works, to examine thoroughly into the importance of this mine, and according to the report that will be made, the government will decide on the steps to be taken with reference to it." &c.

On our return and after we had made our report on the developement of the emery formation in three distinct places, distant from each other, to wit, in Gumuchdagh; near to Kula; and to the north of Smyrna; the monopoly of this mineral was offered for sale, and purchased first by Mr. Langdon of Smyrna, and subsequently by the house of Abbott & Co., for the sum of twelve hundred thousand piastres per annum (fifty-five thousand dollars), and about the month of August some eight hundred tons from the summit of Gumuchdagh were in England. Thus when M. Tchihatcheff thought to have discovered this emery for the *first time in situ*, in December, 1847, and when he wrote to you the following words: "The brilliant prospect that Asia Minor presents in reference to this mineral, and which I am happy to have first pointed out," &c., and at the end—"I have communicated the necessary indications to Mr. Lawrence Smith, American Mineralogist, in the service of the *Porte*,

who proposes to develope my discovery." I say, when this was written to you, already near a year had expired since I had made the discovery; it was publicly known by the announcement in the Journal of Constantinople, the 16th May, 1847, and the "brilliant prospect" was already appreciated by the Turkish government, and eight hundred tons from the summit of Gumuchdagh were in England. Wherefore I claim the priority of the discovery of emery in Asia Minor, *in situ*, and to have been the first to have made known publicly this discovery.

The reason why I did not make this discovery known to the scientific world, was, because I intended to make a complete memoir on this subject after an examination of certain points, which is not yet finished; I will mention only one or two to which my investigations have led me; they are the discovery of the existence of the oxyd of zirconium in emery, and of a new mineral that I have found associated with emery coming from all the localities of Asia Minor and of Naxos. It is a micaceous mineral having for composition, silex 30, alumina 50, zirconia 4, lime 13, oxyd of iron, manganese and potash 3. I have decided to call it *Emerylite*, and to give at some future time a full description of it.

One word upon the aspect of emery, which M. Tchihatcheff has compared to the hydrated oxyd of iron. In all my observation, I have not yet seen a specimen that can be compared to this oxyd; even at first sight it resembles more nearly the protoxyds, the silicates and *anhydrous* oxyds of iron. The fracture is irregular, except in a species of inferior quality from Gumuchdagh, which has a conchoidal fracture and the aspect of black limestone. I have made other observations more or less interesting but I reserve them for another time.

3. *Chrome and Meerschaum of Asia Minor*; by J. Lawrence Smith, (communicated with the preceding.)—In my journey to the south of Broosa, (Anatoly, Asia Minor,) I crossed a formation of serpentine and other magnésian rocks of considerable extent. Fifty miles from this city I discovered *chromate of iron* disseminated in these rocks; and ten or fifteen miles farther south (near the city of Harmanjick) there is an abundant deposit of this mineral. A circumstance worthy of remark, is, that this chromate of iron (the first that has been discovered in Asia Minor) is found in serpentine as elsewhere. This important fact can explain to a certain extent the formation of this chromate. It is well known that serpentine contains all the elements of chromate of iron, which, during the consolidation of this rock, might separate themselves by the force of segregation, so well known to operate in many geological phenomena. Two facts which seem to confirm this supposition, are, first the existence of the chromate of iron in masses and not in veins, and secondly, the pale color of the serpentine associated with the chromate. One small specimen that I have, consists of a white rock, composed principally of carbonate of magnesia in which small specks of chromate of iron are visible. It is possible that this carbonate is the result of the decomposition of the serpentine at the surface, by the action of water containing carbonic acid. It is only at this locality that I found crystals of the chromate, octahedral, but very small.

This discovery is of great importance to the arts and to the Turkish government, which proposes exploring the mine.

In quitting the locality of chrome, and going northeast, I traversed in several places the serpentine containing veins of carbonate of magnesia, quite pure; and this occurs until we arrive at the plains of *Eskihi-sher*. It is from different parts of this plain that comes the meerschaum most esteemed in the arts. Its geological position is very different from what I had expected. The plain in which it is found is a deposit of drift; a valley filled up with the *debris* of the neighboring mountains, consolidated by lime in which I found no fossils.

The meerschaum is found in this drift in masses more or less rounded, the other pebbles are fragments of magnesian and hornblende rocks.

I have examined with care the neighboring mountains which surround the plain, and have found that the rocks are of the same nature as the pebbles in the plain, except those of the meerschaum; but on the other hand, I found carbonate of magnesia in the mountains which is not to be found in the plains. And this makes me suppose that the meerschaum owes its origin to the carbonate of magnesia of the mountains, decomposed after its separation by water containing silica.

If this supposition be true, we should naturally find meerschaum which not being completely altered, contains the carbonate of magnesia. A chemical examination of several specimens has served to establish this fact. I have the honor to send you a specimen taken at the depth of ten feet—and if you desire to make the experiment yourself, put a small piece of the specimen, well cleaned, in hydrochloric acid, you will have immediately an effervescence which will continue for some time; the piece will not change its form, it only absorbes the acid; the solution will be found to contain chlorid of magnesium nearly pure. Another proof that the meerschaum probably owes its origin to the carbonate of magnesia is, that I have found attached to the meerschaum, serpentine similar to that found in contact with the carbonate of magnesia of the mountains.

The meerschaum of *Eskihi-sher* differs completely from several other specimens that I have seen coming from the localities and which exist in the fissures of rocks—it is certain that the quality of the first is most esteemed.

4. *Axinite in Maine.*—Dr. T. N. True says in a letter to one of the Editors, "I have a good and well defined specimen of axinite in crystallized quartz from the town of Wales, Me.; but although the quartz is in place I could find but a single specimen of this rare mineral.

5. *Copper of the Lake Superior Region*, (from a recent letter by C. T. Jackson.)—The native copper mines of this region are truly wonderful, both for the quantities that are exposed in the mines and the magnitude of the masses of native metal. Truly they are *copper veins*. I have seen the most noble lumps in place, and one has lately been blown off in stoping in the Cliff mine, Eagle river, that will weigh fifty tons! It is now cutting up into pieces of two or three tons weight, so that it may be sent to market. The supply furnished by that mine is as regular as it is in most mines furnishing ore. This spring the miners had four hundred tons on hand, and they have sent down to

Baltimore six hundred tons at this time, and they estimate the amount of copper that they will ship at from nine hundred to one thousand tons before the close of navigation in November next. This mine has been wrought with proper energy, and will richly repay the owners. There are several other native copper mines here that are equally promising, and will produce well when wrought with proper energy and skill.

Copper Falls mine is an example, and is doing well. The Northwest is another full of promise, and I have seen others which look very rich, but which are not yet opened deep enough to exhibit their contents. The shafts at the Cliff mine are 205 feet deep, and the hill above shows the vein in the face 213 feet higher, so that we know that the copper extends at least 418 feet. Those who were surprised that I recommended working mines for *native* copper, should come and see and they would believe. The case is indeed a new one, and we watch with interest the results.

Native silver is found mostly at and near the junction of the trap and sandstone where the veins end, not passing into the sandstone.

6. *Observations on the "Old Crater" adjoining Kilauea, (Hawaii,) on the east;* by Rev. C. S. Lyman, (from a letter dated Upper California, January 30, 1848.)—The "Old Crater" is a pit a mile in diameter, and five hundred or six hundred feet deep, separated from the present active crater by an isthmus of earth, about a quarter of a mile in width. I spent a day ransacking it. The bottom is covered with lava in thick strata resembling ice left in the bottom of a pond after the water has been drawn out. This covers an area three-quarters of a mile in diameter, and rises around the sides of the bowl-like concavity some forty or fifty feet above the level of the bottom. I noticed projecting perpendicularly from the bottom, a great number of stone pillars of various sizes, from one to two feet, and of heights from one to twenty feet. On breaking off some of them I found them tubular and filled with charcoal. The specimen in the box is a portion of one of these tubes with the lava injected into the seams of the charcoal. I could conveniently bring away only this specimen, hoping to get more at another visit which has not yet occurred. The philosophy of this specimen I take to be this. At some comparatively recent period, the lava burst out far up the sides of this pit and even upon the neck of land between the two craters and flowed down into the bottom—at that time a forest—filling it up to the depths of forty or fifty feet, with a lake of lava.* The lava in contact with the trees, would be cooled at once into an encasement of stone from two to six inches in thickness, while the rest of the mass remained fluid. The trees would of course be almost instantly reduced to charcoal, and a crust often a foot or so in thickness must have cooled on the surface of the lake. The lake must then have been drained off subterraneously, while the crust descending, like the ice on a pond when drawn off, would be pierced by these solid encasements of the trees, and finally lie scattered over the bottom in huge cakes, as ice would among stumps on the bottom of the pond, leaving these curious tree-encasements projecting as they now do.

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* In 1832. See Geol. Rep. Expl. Expedition by J. D. Dana, pp. 186, 211.

III. Zoology.

On the Boring of Mollusca into Rocks and on the removal of Portions of their Shells; by Mr. A. Hancock, (Proc. Brit. Assoc., Athen., No. 1086.)—The author stated that three theories had been advocated as to the way in which the mollusks effect their entrance into the rocks, &c., in which they are found. The first is, that the animal works with the shell in the manner of a rasp or an auger. The second, that it secretes an acid whereby the substance with which it comes in contact is dissolved. The third, that the effect is produced by the vibratile action of the parts exciting constant currents of water against the substance, aided by its impetus when drawn in down the elongated body of the animal. The author objected to all these theories. In opposition to the first, he stated that the burrows are tortuous and of a form to render it impossible that the valves of the shells should act as a centre-bit or auger. Again, the spines that cover many of the shells are covered with an epidermis which, if the shells were used for boring, would be rubbed off—which is not the case. The young of these creatures commence boring directly they are hatched, when their shells are too delicate to produce any effect on the substances into which they penetrate. In opposition to the theory that a solvent is employed, the author stated that this must be of an acid nature, and that by the most careful experiments he had been unable to detect the slightest indication of any acid secretions from any part of the bodies of these animals. Besides, if a solvent were secreted capable of dissolving calcareous and sandstone rocks, ought it not also to act on the shell of the animal?—which was found not to be the case. The physical appearances of the excavation, also, were not like those produced by a solvent. It would not account, either, for their boring in wood. The wood found in the stomach of the *Teredo navalis* was found to be chemically unchanged. The theory of the ciliary currents was objected to on the ground that it was inadequate to explain the phenomena. If these delicate ciliary currents were capable of effecting this object, the dashing of the water over the same surfaces ought to have as much more effect as their physical force is greater. The anatomical structure of the part, also, on which the cilia are situated would forbid the supposition that currents produced by them could effect this object. These theories being insufficient to explain the phenomenon, the author proposed a new one. He believes that the anterior portion of the animal is the excavating instrument. This, in *Teredo* and *Pholas*, is composed of the foot and edges of the mantle, which together fill up the frontal gape of the shell. In *Saxicava* and *Gastrochæna* it is formed wholly of the edges of the mantle, which are united and thickened. The form of the excavation corresponds to the form of these organs. On a minute examination of the surface of the foot of *Teredo Norwegica* it is found, under the microscope, to be crowded with minute brilliant points, which on being compressed, consist of comparatively large crystalline bodies embedded within them. These crystals are numerous and of various sizes and shapes, chiefly five and six-sided, but not by any means regularly so. They all agree in hav-

ing one or more elevated points near the center. These bodies are highly refractive, and are for the most part pretty regularly distributed over the whole convex surface of the foot, but are occasionally congregated into masses. Similar crystalline bodies are embedded in the edges of the mantle surrounding the foot. In *Pholas* the same appearance is presented both in the foot and the surrounding edges of the mantle. *Saxicava rugosa* has also the anterior portion of the animal abundantly provided with crystalline bodies like those already described; so also with the foot and mantle of *Patella vulgata*. These bodies are constantly being shed. Acetic acid has no effect on them; and in *Saxicava*, strong nitric acid produces no change after several days' immersion. Those of *Pholas* and *Teredo* appear to be ultimately acted on by this acid, but are never totally destroyed by it. It is by means of these bodies that the author believes the animal rasps down the substances in which they are found. The whole of these animals are also supplied with powerful muscles by which they may effect the necessary movement for the production of this result. Judging from analogy, the author believes that all the boring mollusks excavate in the same manner; none by the rasping or cutting of their valves, none by a solvent, none by ciliary currents. In the same manner he accounts for the gradual disappearance of certain portions of the columella in the gasteropodous Mollusca; not by the process of "absorption," as has been supposed.

Mr. Phillips explained more fully the nature of the boring process carried on by these animals, and thought the author of this paper had thrown much light on the subject. Granules on the tongue of many of the Mollusca had been long known. They appeared to be of a siliceous character.—Prof. Owen stated that there was no *à priori* objection to the theories opposed by the author, and one or another had been adopted by naturalists to explain the phenomenon of boring. At the same time, the inadequacy of these theories for the explanation of some cases had led him to regard the foot and mantle as engaged in the operation,—how, he now, for the first time, was informed. He still, however, thought that an exception ought to be made in the case of *Pholas navalis*, which he yet believed must burrow in wood by means of its shell.—Prof. E. Forbes said that having to write on this subject in his "History of the British Mollusca," he had carefully gone over the evidence in favor of all the views adopted, and was not unaware of those of the author. He found little evidence to support the theory of a solvent being employed, or of the agency of ciliary currents; but he found as little in favor of the siliceous particles of the author. He had carefully examined *Saxicava*, and could find no siliceous granules. Mr. Henfrey had examined these creatures under the microscope, and had failed to detect anything of the kind. A chemical examination made by Mr. Henry had also failed to detect them. He did not deny that they might be present in *Clavagella*. Under these circumstances, he had endeavored to take an eclectic view of the subject. The different substances into which these animals penetrated might require different means. Some species of the genus *Pholas* bored in wood, some in stone, but none in both.—Mr. Hancock had referred to a species of sponge, the *Cliona*, as a borer. This animal was undoubtedly irritable,

but he doubted if it made itself the holes which it occupied.—Mr. Bowerbank could bear testimony to the irritability of *Clione*, but he did not believe that it bored. He believed it to be a true sponge. It had spiculæ and tubes like a *Halichondria*. With regard to the application of the author's theory to the absorption of the columella of shells, he did not think it was necessary, as the researches of Dr. Carpenter and himself had shown that the shells of the Mollusca were organic and susceptible of absorption.—Dr. Carpenter had seen in the borders of the mantle of Terebratula, siliceous particles in the form of spines. It was not necessary that the granules should be silex, as any hard substance would be sufficient for the purpose. He had seen Pholades in such a position in an excavation, as to render it impossible that they should have turned round for the purpose of boring.—Mr. Jeffreys stated that he had observed that the tongues of many forms of Mollusca were constantly renewed in the manner mentioned by the author as occurring with the siliceous granules.—The President drew attention to a fact stated by Mr. Osler in his paper in the *Philosophical Transactions* on the boring of mollusks, that in one instance he had observed that the *Saxicava rugosa*, in boring through a calcareous rock, had been arrested in its course by a layer of argillaceous matter, thus lending great support to the solvent theory.

IV. Astronomy.

1. *Denial of the Discovery of the tenth asteroid, Diana.*—The announcement (in vol. vi, p. 278, Sept., 1848), of the discovery of another asteroid, Diana, by Prof. Kaiser of Leyden, proves to have been premature. The statement was derived by us from the Literary World, of July 8, 1848, which was corroborated by a paragraph in the newspapers that the announcement had been made in Schumacher's Journal. As we find no allusion to this alleged discovery in the European Scientific Journals, we cannot doubt that the statement was entirely erroneous.

2. *Ecliptic Star Charts.*—It is well known that Mr. J. R. Hind, the able Superintendant of Mr. Bishop's Observatory in London, announced a year since or more, a series of star charts comprehending all the stars down to about the tenth magnitude, within the vicinity of the Ecliptic, for the purpose among others, of facilitating the search for new planets. The first sheet, (Hour I.) accompanied with remarks and notes, was advertised for sale in January, 1849, price 2*s.* 6*d.*

V. Miscellaneous Intelligence.

1. *Observations on California;* by Rev. C. S. Lyman, (from Mr. Lyman's recent correspondence.)—I have been in the country now two months, lacking four or five days—have visited San Francisco and Monterey, and the one hundred and fifty miles of country between. A magnificent plain, one of the finest in California, stretches almost from one place to the other. On the middle portion of it I now am. You may ride hundreds of miles over land covered with stout oats growing

wild, and of course going to waste except what the cattle and horses eat. The farms in this country embrace from ten or less to fifty or one hundred square miles; of course the farm houses are many miles apart. The principal source of income to the owners is from the cattle kept on them—many herds numbering thousands of heads. Beef is very abundant, and is the Californian's life. The climate inland—e. g., in this valley where I now am, is the most delightful imaginable. During the six or eight months of the summer season there is scarcely a drop of rain or a cloud in the sky, but a pure bracing air with cool nights resembling our finest September weather in New England. You sleep under a blanket the year round—have no showers to look out for—and can take a journey of weeks or months without an umbrella. The great want here is of water, yet in agriculture it is little felt, since much of the land has sufficient natural moisture. On this farm, for example, there are thousands of acres of green grass all the year around; melons, corn, potatoes and all kinds of vegetables grow green and rank without irrigation.*

On the coast the climate is widely different. At San Francisco one dresses in woolens throughout, even in midsummer—as much so as for the coldest New England winter. There is a great deal of chilly fog, and the thermometer since I landed, July 3d, has ranged between 50° and 68°—the latter being the highest I have yet seen it in the shade, even at 2 P. M. of a bright cloudless day. You may think it almost an incredible story—and it is indeed the most wonderful climate I ever heard or conceived of.—(*From a letter, dated San Francisco, August* 30, 1847.)

During the six months I have been here there has been but little more than a week's rain, and that fell chiefly a fortnight since. The weather for two weeks and a half past and almost entirely up to that rainy week, had been mild and delightful, a cloudless sky with fine bracing air, like the clear weather of the latter part of September with us. Most of the mornings since the first of December have been frosty, and at morning and evening a fire is essential to comfort. I am now writing in a room without fire or fire-place, and with doors and windows open on two sides, and all my mapping and plotting this winter, I have done in a chamber without a fire. Snow and ice never trouble us. This is very different from your weather only four degrees north of us. —(*From a letter dated South of San José, January* 30, 1848.)

The immense gold deposit in the Sierra Nevada has been the prominent object of thought in California the last six months, and it will be so for years. I have visited several different parts of it. * * It is every where extremely rich. Its length along the Sierra has already been explored some four hundred miles, and rich *diggings* have been actively worked. At a moderate estimate, probably four or five millions of dollars at $16 per ounce troy, have already been taken out since the workings were first commenced about nine months ago, most of it with-

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* The region here described lies south of San Jose, between ranges of the Coast mountains. It is west of the great valley of San Joachim and Sacramento, where the climate is warmer and drier.—J. D. D.

in the last four months. As the explorations proceed, the results become richer and richer; from four to six thousand people probably have been digging, and the average day's work for the whole would hardly fall short of an ounce. Five, six and ten ounces are not uncommon days' works, and some, individually, have taken out two, three, four, and even ten or more pounds of gold in a single day. I design at my earliest leisure to write a pretty full description of the *placers*, and its geological associations. Suffice it to say that the rocks of the Sierra Nevada range are primitive and metamorphic, and that the gold occurs so far as I have observed, solely in one geological position, namely, the stratum of drift or diluvium, which in places where the diggings have been carried on, varies from half a foot to several feet in thickness. The richest excavations have been in the bottoms of dry ravines, though gold is found on the slopes, and even on the summits of the hills. Single pieces have been reported as weighing fifteen and twenty pounds, but the largest I have *seen* is one at present in my keeping. It weighs between six and seven pounds troy, being composed of a large proportion in bulk of quartz rock with metallic gold interspersed,—the weight of the gold amounting probably to two and a half or three pounds.—(*From a letter dated November* 17, 1848.)

Another letter from Rev. C. S. Lyman, relating to the mines of quicksilver in California, and giving one of the earliest announcements of the discovery of gold, was published in volume vi, of this Journal, p. 270, September, 1848.

2. *Analysis of Ashes;* extract from a letter from Mr. FLEITMANN of Berlin to Prof. HORSFORD, (communicated for this Journal.)—"Every one occupied with the analysis of ashes, knows the difficulties which accompany the incineration of many substances. The escape of alkaline chlorids during the process is known to be great. Other salts are driven off or altered—especially the phosphates, which are reduced by charcoal at the high temperature necessary for combustion. Starting with the supposition that the principal cause of the difficulty of burning the charred masses arises from the envelope of fusible salts, which exclude the free access of air, I tried to improve the process by obstructing that influence. I succeeded in this by charring the substance, powdering, moistening with bichlorid of platinum, and igniting the whole in the open air. In this manner the whole substance became penetrated with a fine net work of platinum sponge. The well known property of platinum sponge, of absorbing oxygen in its pores and transferring it to combustible bodies, is here of great avail. This property shows itself in so striking a manner that frequently the charcoal prepared with platinum as indicated, when once lighted, continues in a state of ignition for hours without the application of external heat. The maximum quantity of platinum is half a gramme for ten grammes of charred substance. The separation of the platinum from the ashes is simple; one difficulty has to be opposed. In most cases where the charred substance is incorporated with the solution of chlorid of platinum, a quantity of double salts of platinum is formed, which cannot be perfectly decomposed by simple ignition. A reduction by means of hydrogen, is therefore unavoidable.

The determination of the chlorine contained in the ashes is, of course, to be made beforehand. The substance is to be charred in a well closed Hessian crucible, then completely extracted with water, and the chlorine determined from that solution. In my analyses, I used to analyze this solution by itself. I then proceeded to extract with hydrochloric acid, and analyzed this solution separately and also the residue. I did this at the request of Prof. Rosè, who on the ground of these results founds a theory which he will soon publish."

"I give below the result of my analysis of the fæces and urine of man, which I have tried to make interesting by enabling a comparison to be made between the inorganic matters they contain, and those contained in the food at the same time.

I carefully collected for four days the solid and liquid excrements of a young man. The sum of the constituents in both can without doubt be regarded as equivalent to the corresponding quantities in the food. The following quantities are calculated for the period of twenty-four hours.

	The fæces of one day contain		The urine of one day contains	
Na Cl	= 0·0167	grammes	= 8·9243	grammes.
Na O	= 0·0185	"	= ———	"
K Cl	= ———	"	= 0·7511	"
KO	= 0·5455	"	= 2·4823	"
CaO	= 0·5566	"	= 0·2245	"
MgO	= 0·2781	"	= 0·2415	"
$Fe_2 O_3$	= 0·0544	"	= 0·0048	"
PO_5	= 0·8072	"	= 1·7598	"
SO_3	= 0·0293	"	= 0·3864	"
SiO_3	= 0·0375	"	= 0·0691	"
	2·3138		14·8438	

The difference in the proportions of potassa and soda in the fæces and urine, is remarkable. The quantity of soda in the fæces is in no proportion to that which is secreted daily in the body as bile, and shows that the bile must be removed from the body by another way than the fæces."

3. *Aurora Borealis of Nov.* 17, 1848.—The display of the Aurora Borealis seen in the United States and even as far south as Cuba, (see p. 127 of this volume,) on the night of November 17, 1848, was probably as wide spread as any to be found on record. A letter from Rev. Samuel J. Parker, Ithaca, N. Y., communicates his observations, which show that the exhibition has rarely, if ever, been surpassed in these regions. I give a single extract, "At one time the circular spot south of the zenith (the corona) was the only part of the heavens destitute of the aurora; indeed for two hours most of the time, this was the case. The rays of course ran from the horizon to this spot,—from the southern as well as the northern horizon."

The same phenomenon was observed in Smyrna, Salonica and Odessa. The subjoined description of its appearance at Odessa is taken from *L'Impartial* of Dec. 1, 1848, a newspaper of Smyrna, for which I am indebted to Rev. Henry A. Homes of Constantinople. It was also observed at San Francisco, California, by Rev. C. S. Lyman,

whose interesting account of the display I extract from his letter to me, dated at the place last named, Nov. 18, 1848. E. C. H.

(1.) *Odessa*, 46° N. lat. 31° E. lon. "On Friday last, November 5, O. S. (17th), our city was favored for two hours with a phenomenon extremely rare here. A magnificent Aurora Borealis overspread a large part of the heavens. At seven o'clock the light in the north led to the supposition of a distant fire, but its continuance and mild character dissipated all doubts; it was certainly the Aurora Borealis, although faint. Towards eleven o'clock, the light hitherto diffuse, appeared in more distinct sheafs, and columns of various lengths, rising almost vertically from the horizon to the zenith, without touching either; the moving rays successively increasing and diminishing, and shooting with more and less brilliancy. At eleven this sea of white light began to assume a rosy tint, which every moment became deeper; the whole sky below Ursa Major, and to a great distance right and left, at this time presented the sublime spectacle of a vast conflagration, fed by some immense invisible city,—for the horizon below was blue, (or rather of that bluish white which is said to be a sign of cold.) Towards the zenith the moving sheafs of tinted vapor were lost in hues of purple and violet and in the deep blue of the starry sky. At $11^h\ 10^m$ the entire tail of Ursa Major was covered with the blood-red sea; five minutes later, the rosy tints gradually faded. The display seemed about to terminate, but soon passing now more to the left, below the polar star, the reddening began with still greater intensity, and covering more space than before. Still shifting from white to more vivid hues, the phenomenon continued visible until an hour and a half after midnight. During the whole time the air was calm and mild. The morning of that day had been windy and cold: between 2 and 3 P. M. some flakes of snow had fallen; the temperature became milder at evening."

(2.) *San Francisco, Up. Cal.*, 38° N. lat. 122° W. lon. "Last evening there occurred here a beautiful exhibition of the Aurora Borealis, similar to those witnessed at New Haven eleven or twelve years ago. This is the first glimpse I have had at any auroral appearance since I left the United States, [Oct. 1845.] I was at my camp on the western side of the Bay of San Francisco, eighteen miles south of this place, and in lat. 37° 37′ N., long. 122° W. of Gr. My attention was first called to the aurora about half past 6 P. M. (Friday, November 17), when the northern sky presented a beautiful display of waving colored light with a faint appearance of streamers. The prevailing red hue was in all respects similar to that of the Auroras referred to above, strongly resembling the reflection of the light of a conflagration from the clouds. In altitude the light did not reach above the pole star. The western extent of it was the handle of the Dipper, (*Ursa Major*,) and the eastern was concealed partially by light clouds which were scattered over the northern sky, the center apparently coinciding with the magnetic meridian: the declination of the needle at the place being very nearly *sixteen* degrees east. The Aurora gradually grew fainter till a little after seven, when it became entirely invisible. Being quite unwell at the time, I did not sit up to watch for its re-appearance. One of my men however who was up some time in the night, probably about 11 or 12 P. M., told me this morning that it was more brilliant at

that time than earlier in the evening. An old Californian who saw it, said it was the first time he had ever witnessed any thing of the kind.

"The transit of Mercury on the morning of the 9th I was designing to observe as well as I could with the telescope of my theodolite; but the weather proved to be densely foggy where I then was. The August meteors I lost from the same cause.

"There are portions of California where the sky is most admirably adapted to astronomical observations, being almost perfectly cloudless for eight months of the year in succession, and generally unclouded a large portion of the remaining four. Beautiful sites for an observatory might be selected in the neighborhood of *Puebla de San Josè*, fifty miles south of this place."

4. *Gold Mining in Virginia*, (Mining Journal, London, April 15, 1848.)—As every thing connected with the successful results of mining operations, particularly as regards the precious metals, is of the most lively interest, we proceed to lay before our readers some account of a gold mine in the state of Virginia, in North America, supposed to be the most extensively worked, and the best organized of any of the gold mines in the United States. This mine is situate in a fertile and populous country, with good roads, and rapid and easy conveyance, and when we consider the mining districts of South America and Russia, their almost inaccessible situation, difficulty and expense of carriage, &c., the superiority of the situation of those of North America is self-evident.

"The Orange Grove or Vaucluse Mine is situated in Orange County, State of Virginia, near the eastern line of Spotsylvania County, about two miles north of the Swift-run gap turnpike, leading from Fredericksburg to Orange Court-house, one mile south of the Rapidan, or south branch of the Rappahannock River, and about seventeen miles from Fredericksburg. This mine was discovered in 1832, and for a number of years worked as a deposit or surface mine for gold, before the veins or lodes of ore containing the precious metal were discovered. The surface working, or washing, for gold on the estate has been conducted from that time (with few, if any intervals) until the year 1846, always yielding a good profit for the labor and capital employed. The veins or lodes of ore, which are numerous, run N.N.E. and S.S.W., and dip to the N.E. The walls of the same are of various slates. The ores are slate, talcose, schist, and quartz, containing sulphuret of iron, brown oxyd of iron, black and brown hydrates of iron, and the slates near the veins or lodes are highly metalliferous and often colored with iron. At the depth of seventy or eighty feet, the hydrates are often found incrusting the sulphurets, all of which contain gold, and some of which are very rich. The lodes, or veins, vary in size and width, from four to twenty feet, and some bodies of ore are found as wide as thirty or forty feet; most, if not all, are connected, one with the other, by small leaders, or threads. Parallel with these, there has been discovered ore containing native copper in minute crystals, and also the sulphurets and oxyds of copper and iron, all rich in gold, but they have not been worked to any extent, as the native copper forms an amalgam with the gold and quicksilver, which requires the process of cupellation to separate the gold. All the ores here are worked by

amalgamation; there is, however, not the least doubt, but that they can and will be worked to great profit, when the process of smelting is introduced, which is now about to be done, whereby the rich sulphurets and hydrates which are now laid aside, can be advantageously worked. This would add materially to the returns of gold, as agreeably to experiments made on a very large scale, by order and at the expense of the Russian government, it resulted, that a given quantity of ore, which, by the ordinary washing process yielded five-sixths of an ounce, produced by the smelting process no less than seventy-two ounces and five-sixths of an ounce, thus showing, that by this means there was obtained no less than eighty-seven times more than by the old method. In 1844, the present establishment was commenced, the mine purchased, and a powerful and very superior English condensing engine brought on the ground for the purpose. It will be recollected, that the former proprietor commenced operations without the least capital, and had purchased the mine, erected all the machinery and buildings, and built one of the largest, and one of the most complete establishments for mining purposes in the United States, and all from the products of the mine. The mineral tract contains two hundred acres, lying in a long and comparatively narrow strip on the course of the veins, so as to give to each vein a line of dips in length of one and a quarter mile from N.N.E. to S.S.W. There is likewise attached to the same estate, beside the wood on the mineral land, one hundred and fifty acres of wood and timber land for the engine's consumption, or fire-wood. The location is one of the healthiest in Virginia, and its proximity to Fredericksburg and the northern counties makes it one of the most desirable mining properties in this country. The machinery consists of a very perfect condensing Cornish mining-engine, one hundred and twenty horse power, over which is a first rate substantial engine-house, and stack fifty feet high. On the north of the engine and boiler-house is a large frame mill-house, containing six large Chilian mills, consisting of cast iron bed plate, five feet and six inches, and weighing 2200 pounds each. On each of the six bed-plates are two runners, or cast iron wheels, or twelve in number, five feet and six inches, eleven inches face, and two inches thick, running on the edge, the centres of which are filled with heavy oak timber, and each, with their shafts, weighs about 2000 pounds. These mills are situated in two rows, and are geared to, or receive their motion from, the steam engine. As all the ores are ground in water, each mill is supplied with warm and cold water at pleasure; twelve inches from the top of the bed-plate there is a wide open mouth which allows the turbid or thick water (caused by the grinding or reducing the ores) to escape into a trough, by which it is conducted to the tanks or reservoirs. There is likewise in this department the machine for washing the residuum, and obtaining the amalgam and quicksilver hereafter mentioned. On the south side of the steam engine is the stamp-house and amalgamating room, containing six batteries of three stamps each, or eighteen in number, also driven by the engine, and each of which, with the iron head of 125 pounds, weighs 350 to 380 pounds. The stamps of each battery of three are supplied with water, which is regulated by a stop-cock; at each blow of the stamp a portion of fine ore, freed gold and water, pass out of

the boxes through the grates, and thence through troughs to the amalgamating rooms. The bowls are supplied with runners, which move horizontally; in the center of these runners is an eye or opening, like that in the runner of a corn mill. The ground, or fine-stamped ore, gold, and water pass into this eye or center, and by the rotary motion of the same, are brought into contact with the quicksilver deposited in the center, and form an amalgam, the affinity of the one for the other being very great. To the east, and near the eighteen amalgamating mills, are three dolly-tubs, or catch-alls, about five feet in diameter, into which the ore, &c., after passing through the amalgamators run, depositing any quicksilver or gold that may have passed off, should the machinery of the former not work as it ought. After this the whole mass passes to the strakes, or inclined planes, where the sulphurets, &c., are deposited, and the earthy matter washed away. On the south of the stamp or amalgamating house, there were formerly two heavy Mexican drags, or *arastres*, for the reduction of sands and sulphurets; but, not answering so good a purpose, they have been altered into three heavy Chilian mills, like the six described in the north wing, but rather heavier. Besides the buildings for the machinery, which are all of substantial frame, there are dwelling houses for agents, superintendents, boarding houses, carpenter's shop, store-house, blacksmith and machine shop, grist-mill, cabin for one hundred to one hundred and fifty workmen, stabling for twenty horses, and all necessary out buildings, as bake house, kitchen, &c. The buildings are all in good order and new. The ore is raised from the pits, or shafts, which vary from thirty to eighty feet deep, by hand windlasses and horse-whims, in iron bound buckets, to which are attached well tried iron chains, imported for the purpose, instead of ropes. The ores, on arriving at the surface, are divided into but two classes—coarse and hard ore for the stamps, slate and fine or small ore for the Chilian mills; this is done by means of a large screen. The ore which passes through this screen is sent in carts, or by railroad, to the mill-house, and the coarse, or large pieces, to the stamps; the very large pieces are first broken with hammers, but this is seldom required. The water is raised from the different shafts or pits, as it accumulates in the mines, and runs from thence to the dam, or great reservoir, where all the water from the various branches, as well as the pits, is concentrated, and passes through a tunnel to the large well-room, in which are located one seven-inch and one four-inch lift or pump, to raise the water into a large cistern, containing 7000 gallons, for the steam-engine, mills, stamps, and all other purposes required in the working and washing processes. Attached to the steam-engine by a connecting-rod or joint, and raised on a heavy frame-work above the working beam of the same, is a large balance-bob made of heavy oak timber, the out end of which works outside the engine-house. There is connected or attached a large sliding-rod, passing down into the pit or well-room; to this is connected by offsetts the two lifts or pumps as above mentioned, and likewise another or second bob, connected at pleasure, which drives the line of flat-rods, leading to the different pits, where they are connected by the different bobs, to the lifts or pumps in the shafts, from which the water is raised to the surface.

"The small or fine ores are ground in the Chilian mills in water, which, as before stated, constantly passes off, carrying the finely ground ore and earthy matter with it; the gold, being freed from the matrix or ore, is carried or precipitated to the bottom by its specific gravity. One boy attends three mills a term of twelve hours; at the end of every twelve hours the mills are cleaned out, taking all the residuum of the ore, which has been ground during the term, and which in each mill is reduced to about three common buckets full, in which are the gold and quicksilver, having formed an amalgam; the gold which has been freed falls to the bottom or bed-plates, comes in contact with the quicksilver, for which it has a very strong affinity; this residuum is placed in a strong iron-bound box, sufficiently large to hold the contents of all the mills for the twelve hours, and at the end of every twenty-four hours, or two terms, is washed out, or rocked down in a machine for the purpose, where the gold amalgamates, and the amalgam of gold and quicksilver is obtained and washed clean, which is then strained through buckskin or fine Nankeen, expressing all the superfluous mercury, and leaving the amalgam of gold and quicksilver dry, and in a hard ball. The same process is pursued with the residuum from the stamps, or amalgamators; these balls are then placed, in sufficient quantities, in an iron retort, well luted, the lid or top secured by a strong iron band and thumb-screw; the retort is then placed in a small iron pot or furnace, the mouth of the same being inserted in water. When the temperature of the furnace is raised from 660° Fah., the mercury or quicksilver escapes in vapor, and is condensed in a metallic form in coming in contact with the water; after a short time, say thirty or forty minutes, according to the mass and heat applied, the process is complete—and, on opening the retort, the gold is found, if clean, of a bright yellow color, but porous or spongy; it is then placed in a crucible, and melted with a little borax or potash, and, if impure, a little nitre or saltpetre, is added. When completely fused, it is cast into an ingot, and the work is complete, bringing out a beautiful bar which usually weighs, when full, about 1000 dwts., and of a fineness of ·985 or ·990 fine, or nearly nine per cent. finer than the coin of the United States. The quantity of quicksilver used, and the annual loss in this large establishment, is not over from two hundred and fifty to three hundred pounds, at a cost of $1 20 to $1 50. The quantity of ore ground per day varies according to its quality or character, as hard or soft, quartz or slate, sulphuret or decomposed ores. The machinery is now sufficient to reduce a great quantity, and the engine, which is powerful, is capable of driving much more; the engine cost $10,000 to import from England. The whole establishment is built with a view to permanency and usefulness; the quantity of ore is, without doubt, inexhaustible; the ore varies somewhat in richness, but has always paid a great profit, as the whole establishment, machinery, buildings, also tools, horses, wagons, and carts, fall little short of the cost of $70,000, and have all been procured by the proceeds of the mines, as well as the purchase money of the property. Pieces weighing two, three, and four dwts. (the dwt. of gold from this mine is worth from 98 to 100 c.) have been taken out as deep as from thirty to sixty feet, and from three to four pounds of the ore as much as sixteen to eighteen dwts. have been obtained by pounding and washing."

This description is fully supported by the report of Mr. O. Matthews, mining engineer, and that of a committee of three gentlemen, appointed expressly for an official inspection of the mine, in September, 1847; as also from an analysis by Mr. J. C. Booth, of Philadelphia, of four specimens, producing respectively, 16 dwts. 4 grs., 12 dwts. 12 grs., 6 dwts. 13 grs., and 2 dwts. 12 grs., to the one hundred pounds of ore—who states they would produce three times as much if they could be obtained free from matrix, and that either would yield a rich matt by smelting. The direction of the Orange Grove Mining establishment is, with the exception of two gentlemen, we believe, entirely under the control of British subjects.

5. *On Common Salt as a Poison to Plants;* by W. B. Randall, (Proc. Brit. Assoc., Athen., No. 1086.)—The following notice is presented as being likely to afford a useful practical caution to those interested in the cultivation of plants. In the month of September last, three or four small plants in pots were shown to the writer nearly or quite dead; and he was, at the same time, informed that their destruction was a complete mystery to the party to whom they belonged, and that Dr. Lindley had expressed his opinion from the examination of a portion of one sent to him, that they were poisoned. Having searched in vain for any strong poison in the soil, and in the plants themselves, he inquired more minutely into the circumstances of the case, and found that these were only specimens of many hundreds of plants both in the open air and in the green-houses (but all in pots) which exhibited, in a greater or less degree, the same characteristics. The roots were completely rotten, so as to be easily crumbled between the fingers; the stems, even in young plants, assumed the appearance of old wood; the leaves became brown, first at the point, then round at the edge, and afterwards all over; while the whole plant drooped and died. At least two thousand cuttings in various stages of progress, and one thousand strong, healthy plants had been reduced to this condition; including different varieties of the fir, cedar, geranium, fuchsia, rose, jasmine, and heath. The sight of this wholesale destruction, coupled with the fact that the whole were daily watered from one particular source, suggested the conclusion that the cause of the evil must reside in the water thus used; and this was accordingly examined. It yielded the following constituents, making in each imperial pint of twenty fluid ounces, nearly 9½ grains of solid matter entirely saline, without any organic mixture:

Carbonate of lime,	0·600
Sulphate of lime,	0·462
Chlorid of calcium,	0·200
Chlorid of magnesium,	1·252
Chlorid of sodium,	6·906
	9·420

The mould around the plants and an infusion of the dead stems and leaves also afforded abundant evidence of the presence of much chlorid of sodium. Farther inquiry showed that the well from which the water was procured had an accidental communication by means of a drain, with the sea; and had thus become mixed with the salt water from that source, and had been used in this state for some weeks, prob-

ably from two to three months. From about that time the plants had been observed to droop ; but it was not until nearly the whole of a valuable stock had been destroyed, that any extraordinary cause of the evil was suspected. To place it beyond doubt that the water was really the cause of the mischief, twelve healthy fuchsias were procured from a distance and divided into two parts ; half being watered morning and evening with the water in question, and the others with rain water. In a week the six plants watered from the well had turned brown, and ultimately died, while all the rest remained perfectly flourishing. Assuming, from these facts, that the common salt in this water was the chief cause of the results described, it is proved that water containing about seven grains of salt in each pint is, in its continued use, an effectual poison to the weaker forms of vegetation ; or that when a soil is continually watered with a weak solution of salt, it gradually accumulates in it until the soil becomes sufficiently contaminated to be unfit to support vegetable life. In either case an interesting subject of inquiry is suggested—What is the weakest solution of salt which can produce in any measure this poisonous effect ?—or, in other words, at what degree of dilution does the danger cease ? For salt is an important natural constituent of much spring water, quite independent of any infiltration from the sea, as in this instance. Thus :—the water of the artesian well, Trafalgar Square, London, contains in each gallon about 20 grains ; that at Combe & Delafield's Brewery 12·7 ; that at Wolverhampton Railway Station 6 ; one lately sunk at Southampton, for supplying a private manufactory, 40. May it not be asked, whether the subject of the suitableness of waters in general for the various purposes to which they are applied—be it in manufactures or for steam-engines, domestic purposes or for drinking—is not worthy of a greater share of scientific attention than it has hitherto commanded ?

6. *On the Influence of Temperature upon the Distribution of Fauna in the Ægean Sea;* by Lieut. Spratt, (Proc. Brit. Assoc., Athen., No. 1088.)—After the publication by the British Association of the highly interesting Report of the Distribution of the Fauna of the Ægean by Prof. Forbes, I was led to imagine that temperature might have a great influence on that distribution. With this view I pursued the inquiry by making observations on the temperature of each region as opportunities offered for so doing, whilst employed on the survey of the Ægean Sea during the summer seasons. These results show distinctly that temperature seems to be the principal influence which governs the distribution of the marine Fauna. The summer temperature of the air in the Mediterranean is about 86°, and the surface temperature reaches nearly that temperature generally at that season. The zones of depth as arranged by Prof. Forbes are as follows. The first region includes all between the surface and the depth of two fathoms ; but this he subdivides into a superficial or tidal zone of about two feet : the inhabitants of which, he observes, are remarkable as being such as have a wide range in depth, eight out of eleven species peculiar to it being widely distributed in the Atlantic. The temperature of this zone ranges from 76° to 84° during eight months in the year. Its inhabitants are consequently subject to great vicissitudes of climate during the summer and winter. Nature having thus adapted them to these con-

ditions, we consequently find that they are wanderers through great geographic space, corresponding to the vicissitudes of temperature to which they are subject. The second region reaches to the depth of ten fathoms, in which, with the last subdivision of the first region, we have, says Prof. Forbes, the characteristic Fauna of the Mediterranean. Now the temperature in this region is seldom lower than 74° in the long summer season, and it is consequently the region upon which the Mediterranean temperature has a more permanent influence, for which reason we find in it the peculiar Mediterranean Fauna. The third region descends to twenty fathoms and has a decreased temperature to 68°. In the fourth region it is 62° at the depth of 35 fathoms. In the sixth region the temperature is 56° at the depth of seventy-five fathoms; and in the seventh and eighth regions, to the depth of three hundred fathoms, the temperature decreases only to 55° or 55½°, as far as I was able to ascertain. Thus, between the littoral zone and the lowest region there is a difference during summer of 26°, and sometimes to 30°; and between the second region (the Mediterranean) and the lowest, the temperature is about 20°; thus standing at the average temperature of a high northern latitude. After limiting the Mediterranean Fauna to the second region, Prof. Forbes remarks, that the third is a transition zone; but in the fourth region the Celtic character of the Fauna is remarkable, there being in that region nearly 50 per cent. of species identical with northern forms. In the sixth and lower regions he remarks that although the identical Celtic species were fewer in the lower region, "he found the representation of northern species so great as to give a much more boreal or subboreal character than is present in those regions where identical forms are more abundant." Amongst the Ægean Fauna are some which have a wide range in depth,—there being nine species common to six regions, seventeen to five regions, and two common to all,—more than one half of which are *known* to be wide geographic rangers. They, like the cosmopolite species of the littoral tidal zone, being thus adapted to climatal changes, become consequently ramblers over wide geographic space, as they ramble into representations of climate in regions of depth. Thus, we have the climate of a parallel represented in marine depths as in terrestrial elevation;—and thus it appears that density in depth is not so great an antagonist to the existence of animal life as is generally supposed. The greatest depth at which I have procured animal life is from three hundred and ninety fathoms; but I believe that it exists much lower, although the general character of the Ægean is to limit to three hundred fathoms; but as in the deserts we have an oasis, so in the great depths of 300, 400, and perhaps 500 fathoms, we may have an oasis of animal life amidst the barren fields of yellow clay, dependent upon favorable, and perhaps accidental, conditions,—such as the growth of millepore, now found to be a vegetable instead of a coral,—thus presenting prolific spots favorable for the existence and growth of animal life. These peculiar conditions of density and food develop necessarily a peculiar Fauna, upon which climatal influence, nevertheless, stamps its characteristic forms throughout the species.

Dr. Williams inquired whether the temperature of the water was not different from the temperature of the earth or mud on which it rested

—a point which he believed of material importance. Mr. J. Ball inquired of Prof. E. Forbes how far Lieut. Spratt's researches confirmed his views of the nature of the deep-sea Fauna of the Ægean? Such inquiries as those engaged in by Lieut. Spratt were of great importance for the purpose of ascertaining how far temperature and other causes might interfere with the distribution of animals according to Prof. Forbes's law. He would suggest whether deep-sea observations on temperature might not be carried on better with thermometers dependent on the expansion of solid metals. Prof. E. Forbes expressed his obligations to Lieut. Spratt for the able manner in which he had carried on these researches; they were of great value and interest. In answer to Mr. Ball, he stated that these researches quite confirmed the correctness of the views he had taken with regard to the distribution of animals and plants; and the further researches made by the dredge since the time he had first announced them at Cambridge, had also done so. Dr. T. Williams performed some experiments with an air-pump, from which he inferred that the influence of the pressure of the atmosphere had been very much overlooked in accounting for the distribution of animals in the air and sea. He had also performed some experiments on the distribution of light, which led him to conclude that this agent was much less influential when passing through water than is generally supposed. Sir E. Belcher could generally confirm the correctness of Lieut. Spratt's measurements of temperature. In taking the temperature of the deep-sea he had used an instrument which he described, and which prevented any accident to the thermometer. He had always found the mud or bottom of the sea of the same temperature as the water directly above it. Fish lived at much lower depths than Dr. Williams had supposed possible. He had seen them brought up from a depth of one hundred and fifty fathoms. The bottoms of vessels were examined with great facility by means of tubes, and in clear water the sea bottom had been seen at a depth of thirty-three fathoms. He alluded to the great difference of temperature produced by currents in the sea. Thus, the gulf-stream often exhibited a temperature of 86° whilst the surrounding ocean was not more than 60°. Prof. E. Forbes stated that animals brought up from a depth of two hundred and seventy fathoms lived very well in water on the deck of a vessel—thus showing that pressure had little to do with their existence. The inference, that light penetrated to great depths in the ocean, was founded on the existence of color in plants at those great depths. As a proof that the influence of temperature was very great, he might state that an entirely different Fauna and Flora existed in the gulf-stream from that which existed on its borders. Mr. J. Ball believed that adaptation to pressure was speedily effected in animals. No proper inference could be drawn from Dr. Williams's experiments on light through tubes. The light in water was diffused, and not in tubes. Dr. Carpenter stated that animals differed in their power of bearing pressure. The condor, in descending from its flight, frequently passed through three miles of atmosphere in a few moments. The whale was said to go from the surface to the depth of one thousand fathoms. Man, although at first affected by the rarefied air of a mountain, soon became used to it.

7. *On the Advantageous Use made of the Gaseous Escape from the Blast Furnaces of Ystalyfera;* by Mr. J. Palmer Budd, (Proc. Brit. Assoc., Athen., No. 1086.)—This communication drew attention to an economical application of the heated gases which are usually allowed to escape from the top of the iron furnaces. It appears that the gases which are evolved from these furnaces escape at a temperature which is about the melting point of brass. In the iron works at Ystalyfera, where the iron is smelted by the use of anthracite coal, advantage has been taken of this in a most ingenious manner. By an arrangement, which is in its character exceedingly simple, but somewhat difficult to describe without a model (Mr. Budd's description was illustrated by a very nicely constructed one), the hot gas is led off into another channel by means of a strong current generated through a chamber and air-way from a point just below the top of the iron furnace. It is conducted, very little heat being lost in the passage, under the boiler of a steam-engine; and it is found to be at a sufficiently high temperature to heat the boiler without the consumption of any fuel whatever. Hence an immense saving is effected. Although only one furnace and one boiler has hitherto been adapted to this purpose, it is found to effect a saving of 350*l.* a year. We may consequently expect that when the experiment is further extended and more of the furnaces so arranged that this heat may be economized and employed for the numerous useful purposes to which it is applicable in a large establishment, the saving will amount to many thousands annually. This communication is to be printed entire in the Transactions.

8. *Lawrence Scientific School at Cambridge.*—The programme for the second term of the year 1848–49, from March 1st to July 14th, contains the following announcements:—1. Instruction in analysis and other departments of Chemistry, by Prof. Horsford, during the course of the term, together with lectures from the 2d of April.—2. A course of twenty-five lectures with private instruction on Zoology by Prof. Agassiz. Excursions will be made with those who intend to make a further study of the Sciences.—3. A course of twenty lectures by Prof. J. Wyman on Anatomy and Physiology, with instructions in the use of the Microscope.—4. Lectures on Botany by Prof. Gray through the term, twice a week, commencing with Monday, the 5th of March.—5. Lectures on Mineralogy and Geology by Prof. Webster.—6. Lectures on Experimental Philosophy, by Prof. Lovering.—7. Lectures on Mathematics by Prof. Peirce, from the 1st of March to the middle of June.—8. Instruction in the use of astronomical instruments at the Observatory, by W. C. & G. I. Bond.

The fees for the Chemical course of lectures, *ten dollars;* for the others, *five dollars;* for special instruction in the Chemical laboratory for twenty weeks, including apparatus and supplies, $75; for three days per week, $50; for one day, $25. The special students supply themselves with flasks, retorts, crucibles and other apparatus consumed in using, besides lamps, alcohol, gold and silver solutions.—For private pupils in other departments, not exceeding the rate of $50 per term of twenty weeks.

9. *Daguerrotypes of a Chimpanzee, a species of Orang Otang.*—M. Geoffry Saint Hilaire, presented to the French Academy in October

last, a daguerrotype likeness of a Chimpanzee belonging to the menagerie of the Museum of Natural History, and remarked upon the importance of this method of taking designs of animals.

10. *Climate of Italy.*—M. DUREAU DE LA MALLE closes an elaborate investigation into the climate of ancient and modern Italy, with the conclusion that the limits for different agricultural products were the same in the earlier as in more recent periods, and that from the time of Augustus till the present, there has been no sensible modification of temperature either as regards the months or years.

11. *Goitre due to Magnesian Salts in water.*—The waters of the valley of Isère, have been chemically and geologically examined by M. Grange, with the conclusion that the goitre or cretinism of Switzerland, is due to the deleterious action of magnesian salts in these waters, or perhaps at times to the presence of magnesia and the absence of the lime required by the animal economy. The author suggests as a remedy, the filtration of water in large reservoirs filled with carbonate of lime and a thin bed of lime.

12. *Motive Power*, (Athenæum, No. 1106.)—M. T. DE BEAUVEGARD has constructed a steam-engine to be moved by the vapor of water in the spheroidal state, the elastic force of which being very great; and an experiment is in progress in London on a large scale. The same principle was made use of by Mr. J. C. C. Ruddatz, in 1825, and a patent got out: and subsequently, Mr. Thomas Howard constructed an engine in which water was projected in small quantities upon a plate of iron resting on hot mercury. But these earlier projects were not successful.

In Whitechapel, at Messrs. Horne's, there is an engine worked by the combined influence of steam and chloroform. The steam after doing its work in moving the piston in one cylinder, escapes into another in which there is a quantity of chloroform in small flat tubes. This substance volatilizes at a very low temperature; it is thus converted into vapor by the heat of the waste steam, and in this state is employed to work a second piston. There are, indeed, two engines combined in action, one moved by steam, the other by chloroform. The proposed advantages are the saving of 50 per cent. of fuel. The first engine of this kind was constructed in 1846 in Paris, in which ether was employed, and this engine is still working in a glass factory at Lyons, chloroform being substituted. A Parisian paper states that a powerful and efficient engine of this description has been constructed by M. Charles Beslay, by order of the Minister of Marine. The English patentees propose to use a volatile fluid which is much less expensive than chloroform, equally efficient and less obnoxious.

13. *Coal in the Straits of Magellan.*—There has been a recent announcement of the discovery of coal in the Magellan Straits; if abundant and of good quality, it will prove of great importance to steam navigation. Samples of the coal have been transmitted to the English Board of Admiralty for scientific examination.

14. *Gun Cotton for tooth ache.*—Gun cotton dissolved in ether, constituting what is called collodion, has become an important material for dressing incised wounds. It has been also ascertained that it may be successfully used for the tooth ache. The cavity of the tooth being cleaned out, a little asbestus saturated with collodion, to which a little

morphia is added, is placed in it. All soon becomes solid; and thus an excellent stopping and a powerful anodyne are applied at the same time.

15. *Native Silver in Norway.*—It is reported in the Swedish official paper of the 27th of October, that at the King's mine, at Konigsberg, two lumps of native silver, severally 238 and 436 pounds, were obtained within the preceding two months. This mine was offered for sale in London twenty years ago for £10,000, but failed of purchasers. It now brings to the government more than this sum annually.

16. *Naphtha Spring near Alfreton, England.*—A valuable spring of mineral oil has made its appearance near Alfreton, in a coal pit. The oil has a dark tarry color; but on distillation it affords a volatile liquid which has been found to be a good substitute for chloroform as an agent for acting on the nerves of sensation, besides a colorless inflammable oil, excellent for lamps, and solid paraffine.

17. *Prizes.*—The Belgian government has instituted two prizes, one of five thousand francs with a gold medal, and the other of one thousand francs—the first for the best work on agriculture, and the second for the best treatise on the potatoe-disease. Foreigners are invited to compete; manuscripts are to be sent to the Ministry of the Interior before the 1st of January, 1850.

18. *Chloroform, as a solvent.*—Chloroform dissolves abundantly the various fatty and resinous substances, and generally all highly carbonized compounds. With copal it forms readily a good limpid varnish. It is now known to dissolve caoutchouc, and leaves it with its original properties, on evaporation.

Appendix.—*Observations on California, from the correspondence of the* Rev. C. S. Lyman.—(Continued from page 292.)

The letters from which the following extracts are made, were put into our hands at a late hour. They are not as recent in date as some that have been published in the public papers within the fortnight past: but our acquaintance with Mr. Lyman enables us to vouch for their literal accuracy, and this may give them value in the estimation of our readers. He left the country for his health, and after a residence for a while at the Sandwich Islands, went to California, hoping to be benefitted by the climate, and at the same time to engage in surveying. He had been occupying himself in this pursuit for about nine months, when the discovery of gold carried off his chain-men, "who exchanged $25 a month for as much a day," and he was compelled thereby to suspend his surveying labors.

Gold Mines on the American Fork of the River Sacramento, }
Upper California, August 6th, 1848. }

Finding I could do nothing at surveying, and wishing to examine the gold region, I started thither early in June and was two weeks getting here, on account of the flooding of the river San Joaquin. I had little or no expectations of obtaining gold myself, as I supposed the reports of the richness of the mines altogether exaggerated. But when I reached the ground I found the half had not been told. A company

of five of us made trial of digging the gold on the bank of the Rio de los Americanos, forty miles east of Sutter's, (New Helvetia). We rigged a rude machine in a day for washing the earth, and dug and washed the earth from the river's bank eight days, when we found on weighing, that we had obtained about $350 worth of gold apiece, or 44 dollars a day. The last day's work gave us over 70 dollars, but as we heard others were doing much better ten or twelve miles up, we quitted such *poor* wages, and moved camp for the other place. This was six or eight miles from the river, and in ravines which are dry in summer. Here two of us in company, dug in five days a little over $1000, or over $100 per day apiece, which we thought pretty fair wages. Since that, our success has been various, ranging from $10 to $50, or $80 per day. Others have done much better: able-bodied, hard working men, who happen to have good luck in hitting on a rich place, often get from 100 to 500 or more dollars a day; others have obtained comparatively little.

It is on the whole a precarious business, though almost none that work at all can fail of making from five to fifteen dollars per day. It resembles more than any thing else, a lottery with many large prizes, innumerable middling and small ones, but almost no blanks. My success has probably been not far from the average. A large part of the population of California is assembled here, and probably from two thousand to three thousand people are digging. From 1,000,000, to 2,000,000 or 3,000,000 of dollars have doubtless already been taken from these mines, and the productiveness of them seems almost inexhaustible.

The gold region is as extensive as the whole State of Connecticut. In almost all parts of it in the creeks and ravines, and even on the hills, gold is to be found in considerable quantities. That obtained on the main river is generally in fine grains or scales, averaging the size of flaxseed. This is the kind I obtained when I first came. It occurs in the river alluvium and may be washed out at the rate of about forty or fifty dollars worth from a cart load of earth. In the ravines higher up the river, the gold is larger. Where I got the five hundred in five days it occurred in a gully or ravine dry at this season, and generally within a foot of the surface. Mr. D. and myself dug out the $1000 in the space of about a rod in length, making a ditch of about two feet wide and one deep. While digging we picked up nearly three hundred dollars worth in little lumps visible to the eye. The gold was in little irregular masses, from fine grains to the size of peas or raisins, and occasionally lumps weighing from one to two ounces and as large as walnuts. Under the earth in which the gold is deposited, is a bed of argillite or clay-slate with the edges of the lamina standing nearly perpendicularly, and presenting a very irregular surface, with abundant little pockets for retaining the gold, which is found most plentifully on its surface and in its crevices. In all this region for many miles around, where the gold is dug from the ravines, the underlying rock is some form of this slate, and uniformly presents a dip approaching to perpendicular. On the river the gold stratum rested on *hard pan* or a stratum of coarse granitic sand. The gold is uniformly associated with quartz which is very abundant, and often lumps of gold occur with quartz imbedded, and I have seen pieces moulded on regular quartz crystals.

Two weeks ago I made an excursion into the Snowy Mountains forty-five miles higher up the river. Twenty miles above this, the quartz nearly ceases, and the gold also so far as we could discover; and we passed first a region of gneiss, and afterwards of granite which forms the backbone rock of the Sierra Nevada, or Snowy Mountains. We ascended perhaps eight thousand feet, and approached within eight or ten miles of the snow, though in the middle of July. The range before us in its white robes presented a beautiful appearance.

Gold occurs also in abundance on the Sacramento, the Feather and Uba rivers, Bear Creek, the river Cosumnes, and in short over a region fifty miles wide by a hundred in length—and how much farther I know not.

The discovery of these rich mines may prove beneficial to the States, but it will be a curse to the general prosperity of California. Agriculture, and the arts will be at a stand still;—a few merchants will make fortunes.

In a moral and social point of view, California was bad enough before, but the gold mines will make the matter ten times worse. At the mines, the population is like a nest of ants running hither and thither. Law cannot well be made to exert its power—vice is unrestrained;—hundreds of runaway sailors and soldiers are here, and with their little fortunes dug out in a trice, will have frolicking and drunkenness to their heart's content.

Goods sell at enormous prices. Checked shirts sell to the Indians for fifteen to thirty dollars. Glass beads for their weight in gold. I gave ten dollars for a poor shovel, and ten more for a pick. Flour is from thirty to forty cents a pound,—coffee one dollar,—figs and raisins one dollar,—salt one dollar a quart,—sugar fifty cents to one dollar a pound,—beef from twelve and a half cents to twenty-five cents per pound,—shoes ten dollars per pair,—thin pants eight to ten dollars,—ardent spirits six dollars per bottle, and other things in proportion.

Pueblo de San José, Nov. 6th, 184-.

I left the "diggings" the last of August to avoid the sickness which it was expected would prevail, and which indeed was quite prevalent for several weeks, especially in the vicinity of the Sacramento river. It was chiefly billious and intermittent fever. After spending a month here and at San Francisco, I made a trip to another part of the mines on the river Stanislaus, one hundred and forty miles from this place, and one hundred or more from the diggings where I wrote the letter referred to above. I returned a few days since, having been absent a month. While at the mines, although many of the miners had left, flour was sold at $1.50 per pound, and brown sugar at $3.00. Flour had been sold two weeks earlier from 2 to 4 dollars, and sugar $1.00. These are fair specimens of the prices at the mines. Poor tallow candles bring fifty cents apiece—sperm $1.00 do.—Onions $1.00 a pound—bullocks $100 a piece, and other things in proportion. But the most profitable article of traffic is *liquor*, which of course no man of any principle will have any thing to do with. But while I was at the Stanislaus a fellow opened a grog booth there and cleared over $7,000 in *six* days, and that from two barrels of liquor.

The diggings on the Stanislaus, and several other tributaries of the San Joaquin, have been discovered and opened within the last two months, and many hundreds of thousands if not millions of dollars dug out. Some instances have occurred of individuals obtaining from fifteen to twenty-five pounds of gold in a single day, i. e., from 3,000 to 5,000 dollars. One lump of pure gold was found weighing eighteen pounds avoirdupois. This I have not seen, but am credibly informed of the fact. It was found by Lorenzo Trugillo, a New-Mexican, and I presume he has taken it home with him.

I am told that in one or two places gold has been found *in place*, in veins or beds of quartz interposed among other rocks. But to this fact I cannot vouch, as I have not seen any such myself. Dikes or beds of quartz rock many feet in thickness, and often of great length, are numerous, and generally among nearly perpendicular strata of some form of slate or gneiss rock. All the gold thus far discovered occurs uniformly, so far as I have observed, in one geological formation and no other—i. e., the drift or diluvium, a bed of pebbles and gravel of various sizes lying next beneath the soil, and resting, unconformably, on the rocks beneath—which in most of the diggings are some form of slate or gneiss, running about N.N.W. and S.S.E., and dipping nearly perpendicularly. Like the pebbles of the drift, the gold is uniformly water-worn, and unquestionably was deposited in its present position at the same time and by the same agency as the stratum in which it occurs. It is surprising how little accurate information respecting the region exists even among the thousands of people—many of them intelligent men—at present on the ground. The general impression is that the gold has been thrown from volcanoes in a melted state—numerous places are confidently described as the craters of extinct volcanoes; whereas the entire region is just about as volcanic as the state of Connecticut and no more. The craters spoken of are some of them in a region of *sandstone!* and others among some magnificent ranges of trap or basalt, where from the mural and blackened aspect of the ridges, often arranged in forms somewhat circular, such a mistake is not to be wondered at in persons ignorant of geological phenomena.

The extent of the known gold region is daily augmenting—rich explorations now spreading over a district some four hundred miles in length by thirty or forty at least in width, in almost every part of which gold is to be found in abundance. Probably over $6,000,000 have already been extracted, and next spring the digging will be carried on with redoubled energy. Many have already made handsome fortunes, chiefly those who have had facilities for trading, or had a train of Indians digging for them, or been so lucky as to stumble on a deposit containing its pounds of metal—neither of which three circumstances has happened to me. I have now resumed my former business of surveying, and design to follow it so long as the weather will permit.

It is now nearly time for the winter's rains to set in, but as yet the weather continues delightful. I like surveying much better than gold digging—chiefly because it furnishes some occupation for the mind as well as the body. Living is very expensive here at present, and will continue to be so—the price of labor, provisions and every thing else being proportioned to the abundance of gold. Business is brisk—stran-

gers are flocking in from the Islands, Oregon and elsewhere, and in the spring I suppose there will be a rush from the States.

There is at present little or no government here—society is in an unsettled state—and yet general order prevails to a remarkable degree—a fact which excites surprise even here, and speaks volumes in favor of the American character. As a race our people are lovers of order, and when put in circumstances where there is really no government, their habits of self-government are such that every thing goes on pretty much as it would in any of the old and well governed States. Notwithstanding the thousands of all classes and all countries collected at the mines, back in the wild mountains, without an officer of justice within a hundred miles, and with abundance of rum and gambling, scarcely an instance of serious disturbance has taken place—a shocking murder, committed by a drunken man a few weeks ago, being the first occurrence of the kind that has been known. But in the present state of things—education and moral training being almost wholly neglected, and the country fast filling up with the desperadoes and offscouring of all lands, this state of comparative quiet cannot be expected long to continue. The day of robberies, and outrage, cannot be far distant, and a state of society I fear will prevail that will be anything but desirable.

VI. Bibliography.

1. *Alph. De Candolle, Prodromus Reg. Veg.: pars XII, Sistens Labiatas et quinque minores Corolliflorarum ordines.* Paris: 5r. Nov., pp. 707.—The twelfth volume of the Prodromus, delayed somewhat by the convulsions of the Continent, will be welcome to botanists. It concludes the series of Monopetalæ, with the exception of the small family Plantaginaceæ, and the large one of Solanaceæ, which last, Prof. Dunal—from whom it has long been due—appears to find by no means easy to elaborate. Of the present volume, all but one hundred pages are occupied by the *Labiatæ*, from the hand of the most unwearied and best of monographers, Mr. Bentham. The plants of this large order, arranged in one hundred and one genera, are thrown into eight tribes, instead of the eleven in the *Labiatarum Genera et Species;* the Satureieæ now being made to comprehend the Menthoideæ and the Melissineæ of the earlier work, and the Scutellarineæ being merged in the Stachydeæ. The *Ocimoideæ*, comprising nineteen genera, are represented in extra-tropical North America solely by one or two species of Hyptis, which inhabit our southeastern frontiers.

Of the *Satureieæ* we have *Mentha*, *Lycopus*, a single *Cunila*, *Pycnanthemum* (the whole seventeen species), an anomalous Satureia (S. rigida, *Bartr.*), three species of *Micromeria;* while to *Calamintha* is now referred the former M. glabella and M. Nuttallii, as well as the Gardoquia Hookeri, *Benth.*, with the new C. canescens, *Torr. and Gr. MSS.*, and C. Caroliniana, *Sweet* (Thymus, *Michx.*): also two species of *Dicerandra* (of which D. densiflora is a new one from Florida); the Californian *Pogogyne;* *Hedeoma*, including H. ciliata (Keithia ciliata, *Benth., Lab.*); and *Collinsonia*, of which six species are recognized.

Of the tribe *Monardeæ* we possess a small portion of the vast genus *Salvia*, which is increased to four hundred and seven species; *Audibertia* of California, of six species; *Monarda* of six species (M. didyma and M. fistulosa being retained nearly as in the earlier monograph); and *Blephilia*, of two species.

The tribe *Nepeteæ* affords us *Lophanthus*; a single *Dracocephalum*; and a *Cedronella*.

The tribe *Stachydeæ* furnishes *Prunella*, for which Alph. De Candolle restores, with satisfactory reasons given, the orthography, *Brunella*; *Scutellaria*, of eighty-six species, sixteen of them N. American; *Physostegia*, of which two species are admitted; *Brazoria*, *Engelm.*—*Gray* (in which the synonyme "Physostegia truncata, *Hook. Bot. Mag.*, t. 3194," should be cited under B. scutellarioides, as shown in *Chlor. Bor.-Amer.*, and not under B. truncata); *Macbridea* and *Synandra*, each of a single species; and *Stachys* (from which *Betonica* is now excluded) of one hundred and sixty-eight species.

The tribe *Prasieæ* belongs entirely to the old world and to the Sandwich Islands; and the tribe *Prostantheræ* is exclusively Australian.

Of the *Ajugeæ* we have *Isanthus*; *Trichostemma* (in which a corrected view is taken of the inflorescence of the typical section); and *Teucrium*.

The small order, *Selaginaceæ*, contributed by Prof. Choisy of Geneva, consists of eight almost exclusively South African genera, to which the sub-arctic genus *Gymnandra* is doubtfully appended. Of three Siberian species of this genus two are found on our northwest coast, two are Himalayan, and one has recently been found by Aucher-Eloy in the mountains of Armenia.

The order *Stilbaceæ*, prepared by Prof. Alph. De Candolle himself, consists of three genera each of a single known species, and of one with five species; all of them natives of the Cape of Good Hope.

The *Globulariaceæ*, by the same author, comprises the typical genus, with eight species, and a new one of a single species; all of European and of Eastern Asia, except one in the Canary Islands.

The order *Brunoniaceæ*, also by De Candolle, contains a single genus of two Australian species; both made known by the prince of botanists whose name they bear.

Mr. Boissier, the most active and promising botanist of the Genevan school, has elaborated the *Plumbaginaceæ*. The tribe *Staticeæ* comprises six genera, viz., *Egialitis*, R. Br., of the shores of eastern tropical Asia and Australia; *Acantholimon*, Boiss., of forty-two Central Asian species, and *Goniolimon*, Boiss., of seven North Asian species,—both distinguished from the following by their capitate, instead of filiform, stigmas; *Statice* itself, reaching to one hundred and ten species; *Armeria*, with fifty-two species, and *Limoniastrum*, of two Mediterranean species. The Statice of our own coast, S. Caroliniana, *Walt.*, Mr. Boissier distinguishes from S. Limonium by its fistulous scape, stricter branches, pyramidal instead of corymbose panicle, the distant one-flowered spikelets, and the very acute calyx-lobes; the Californian plant he introduces as a new species. The tribe *Plumbageæ* consists of the Siberian *Plumbagella*; the European and tropical

Plumbago; the Abyssinian *Valoradia;* and the African and North Indian *Vogelia.*

In the Corrigenda to the volume, we notice that Bentham has corrected the orthography of Trichostemma, so printed in the *Genera* of Linnæus, and by mistake in the *Labiatarum Gen. et Sp.* to *Trichostema*, as written by Gronovius, by Linnæus in the *Hortus Cliffortianus*, and as the derivation requires.

The *second part* of the thirteenth volume, to contain the *Phytolaccæ*, *Salsolaceæ*, *Basellaceæ* and *Amaranthaceæ*, by Moquin Tandon, is promised for April next. The *first part* of the same volume, devoted to the *Solanaceæ* and *Plantaginaceæ*, it is discreetly said, will be published later. The vigorous progress of this great work, however, in spite of the overturnings and confusion of continental Europe, at present so disastrous to science, is very gratifying. A. Gr.

2. *Annals of the Lyceum of Natural History of New York*, vol. iv, No. 12, September, 1848.

Wm. L. Jones, M.D.: Description of a New Species of Woodpecker —*Picus LeContei.*—p. 490, with a plate.

J. H. Redfield: Description of New Species of Bullia and Marginela, with Notes upon the Monograph, by G. B. Sowerby, Jr., of the latter genus: p. 491, with a plate.

O. W. Morris: Observations on the quantity of rain at different heights: p. 496.

O. W. Morris: Observations on the state of the weather before and after Auroras and Halos—On the quantity of rain at different elevations, with other Meteorological results: p. 500.

J. F. Holton: On Musical Intonation and Temperament: p. 504.

This number closes volume iv, of the Annals.

The following are the officers of the Lyceum for 1848–49:—

President, Joseph Delafield.—*Vice Presidents*, John Le Conte, Wm. C. Redfield.—*Corresponding Secretary*, John H. Redfield.—*Recording Secretary*, Robert H. Browne.—*Treasurer*, Charles M. Wheatley.—*Librarian*, Robert H. Browne.—*Curators*, B. W. Budd, M.D., J. G. Bell, R. H. Browne, J. C. Brevoort, W. Gibbs, M.D.

Report of Prof. Alexander D. Bache, Superintendant of the Coast Survey, shewing the progress of that work for the year ending October, 1848.—The Survey of the Coast is making good progress under the able superintendence of Prof. Bache. He observes that "during the past year the work has been carried into every State, with one exception, on the Atlantic and gulf of Mexico, and parties are on the way and under orders for the Pacific coast. The operations have been in progress on the full scale in four sections of the coast, including the reduction of the results; work of verification and filling up, and the engraving of charts from the back work, has been continued in the fifth section; the second stage of progress has been reached in a sixth and seventh section, and preliminary reconnaissance has been made in an eighth. The work has been equivalent, at least, to full activity in six sections. The estimates for the next fiscal year will furnish work equivalent to the full scale of operations in seven sections. A base line has been measured in one section, and two preliminary measurements of others made. Six sheets of charts have been published, and ten others are in the hands of the engravers. Thirteen sheets of maps and charts have been drawn in whole or in part within the year, exclusive of assemblage maps, sketches, &c."

Chemical Reports and Memoirs: Works of the Cavendish Society, founded in 1846.—Contains the following memoirs.—Prof. Otto, on the relation of the volumes of bodies in the solid state to their equivalents or atomic weights.

—M. Filhol, on the Connection between the Atomic weights, Crystalline form and density of bodies.—J. Vogel, on Endosmosis.—Prof. Otto, on Isomorphism. —M. Chevreul, on Dyeing.—M. Regnault, on the latent heat of Steam at different pressures.—E. Kop, on the Artificial formation of Alkaloids.—Prof. Bunsen, on the intimate Connection between the pseudo-volcanic phenomena of Iceland.

Henri Lecoq: Des Glaciers et des Climats, ou des Causes atmosphériques en geologie; in 8vo, 566 pp. *Paris*, 1847.

Ernest Puton: Essai sur les mollusques terrestres et fluviatiles des Vosges; in 8vo, 104 pp. *Epinal*, 1847. Extr. de la Statistique du Depart. des Vosges publiée par MM. H. Lepage et Ch. Charton.

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L'Abbé D. Dupuy: Histoire Naturelle des Mollusques, terrestres et d'eau douce, qui vivent en France. 2e fasc. 10*fr.*

Albin Gras.: Description des oursins fossiles du departement de l'Isère. 1 vol. 8vo, with six plates illustrating forty-five species. *Paris*, 1848. 6*fr.*

N. Joly et Leymerie: Memoire sur les Nummulites; brochure in 8vo, with two plates. *Toulouse*, 1848. 4*fr.*

J. F. Ostervald: Recueil de Hauteurs des Pays compris dans le Cadre de la Carte Générale de la Suisse. 126 pp. 8vo, with many tables. *Neuchatel*, 1844–1847.

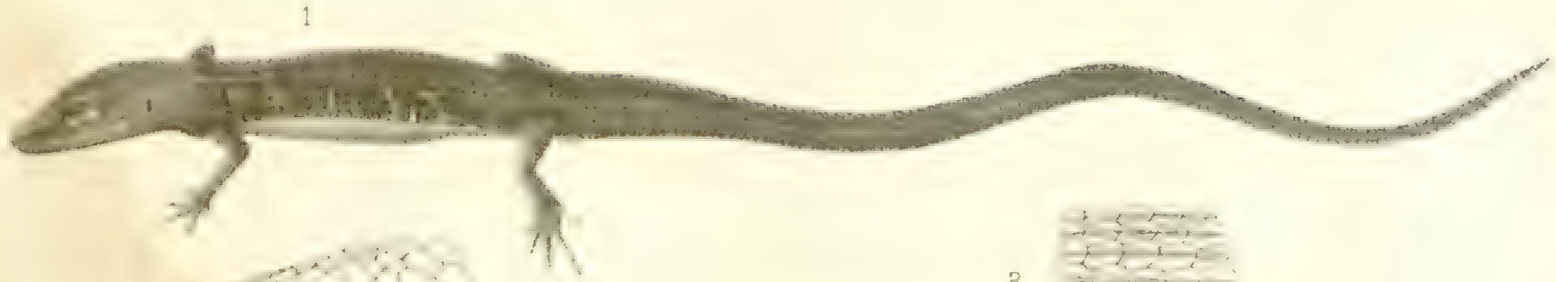
Edward Desor: Embryology of Nemertes, with an Appendix on the Embryology of Polynoë. 16 pp. 8vo, with two plates in one sheet. *Boston*, 1848.

Edward Desor: A new Theory of the Effect of the Tides; 8 pp. 8vo. *Boston*, 1848.

A. Guyot: Sur la Topographie des Alpes Pennines et le gite primitif des principales espèces de Roches qui se trouvent à l'etat erratique dans le Bassin du Rhone, (Extr. du Bull de la Soc. Sci. Nat. de Neuchâtel, 1847.) 16 pp. 8vo. 1847.

A. Guyot: Sur la Distribution des espèces de Roches dans le Bassin Erratique du Rhone, (Extr. du Bull. etc. Neuchâtel) 32 pp. 8vo. 1847.

Annales des Sciences Naturelles, Paris, JUNE, 1848.—On Coral Zoophytes; Milne Edwards and J. Haime (continued.)—On the Osmylus maculatus; *L. Dufour.*—New Crustacean of the genus Macrophthalmus; *Milne Edwards.*—Circulation in Insects; *E. Blanchard.*—On an Amphipodous Crustacean; *M. Edwards.*—New Plants.—15th notice of the Cryptogamous plants of France, *J. B. H. J. Desmazières.*—On the spontaneous phosphorescence of the Agaricus olearius, *D. C.*; Rhizomorpha subterranea, *Pers.*, and the dead leaves of the oak; *L. R. Tulasne.*—Relations between the arrangement of leaves, the form of the vegetable axes and the pith; *L. Cagnat.*—Botanical prize, decreed by the Societé de Phys. et de Hist. Nat. de Genève.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ERRATA.

Page 114, line 2 from top, for *Marbury*, read *Marburg*.

P. 126, line 20, &c., *Southern edge of bear is*, should connect directly with *α Regulus* and *at pi Leonis*.

P. 153, line 20 from bottom, for *porphyry*, read *basalt*

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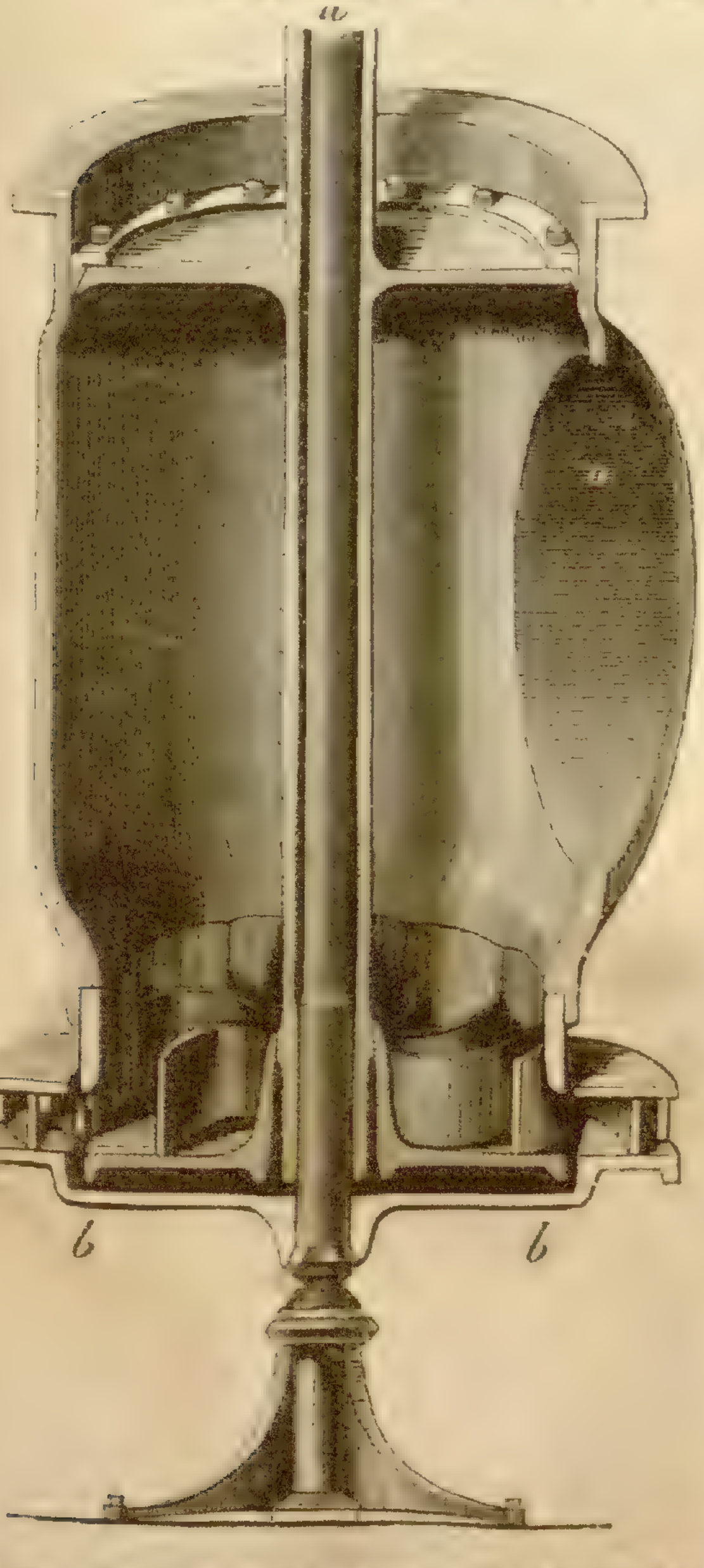

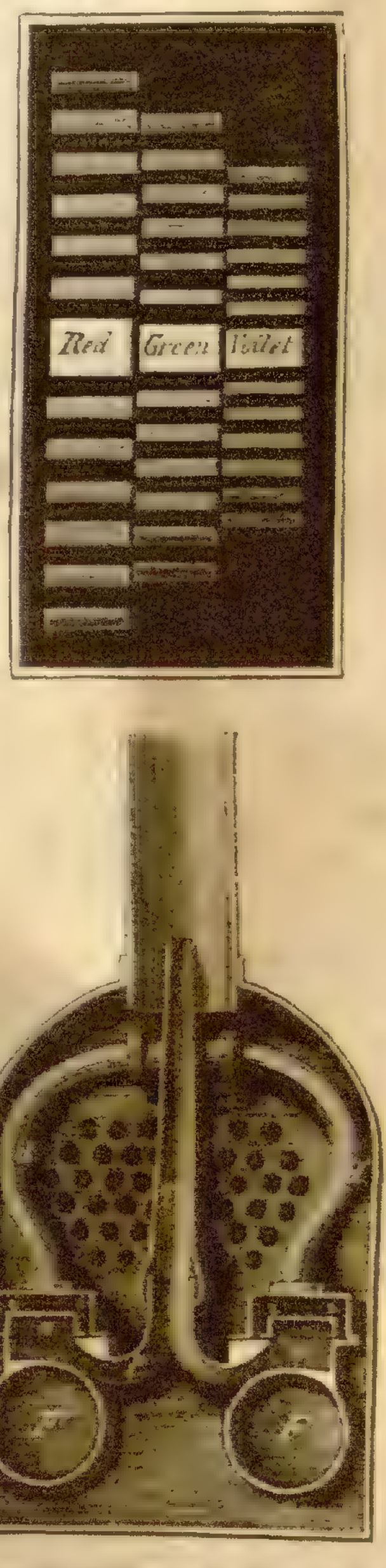

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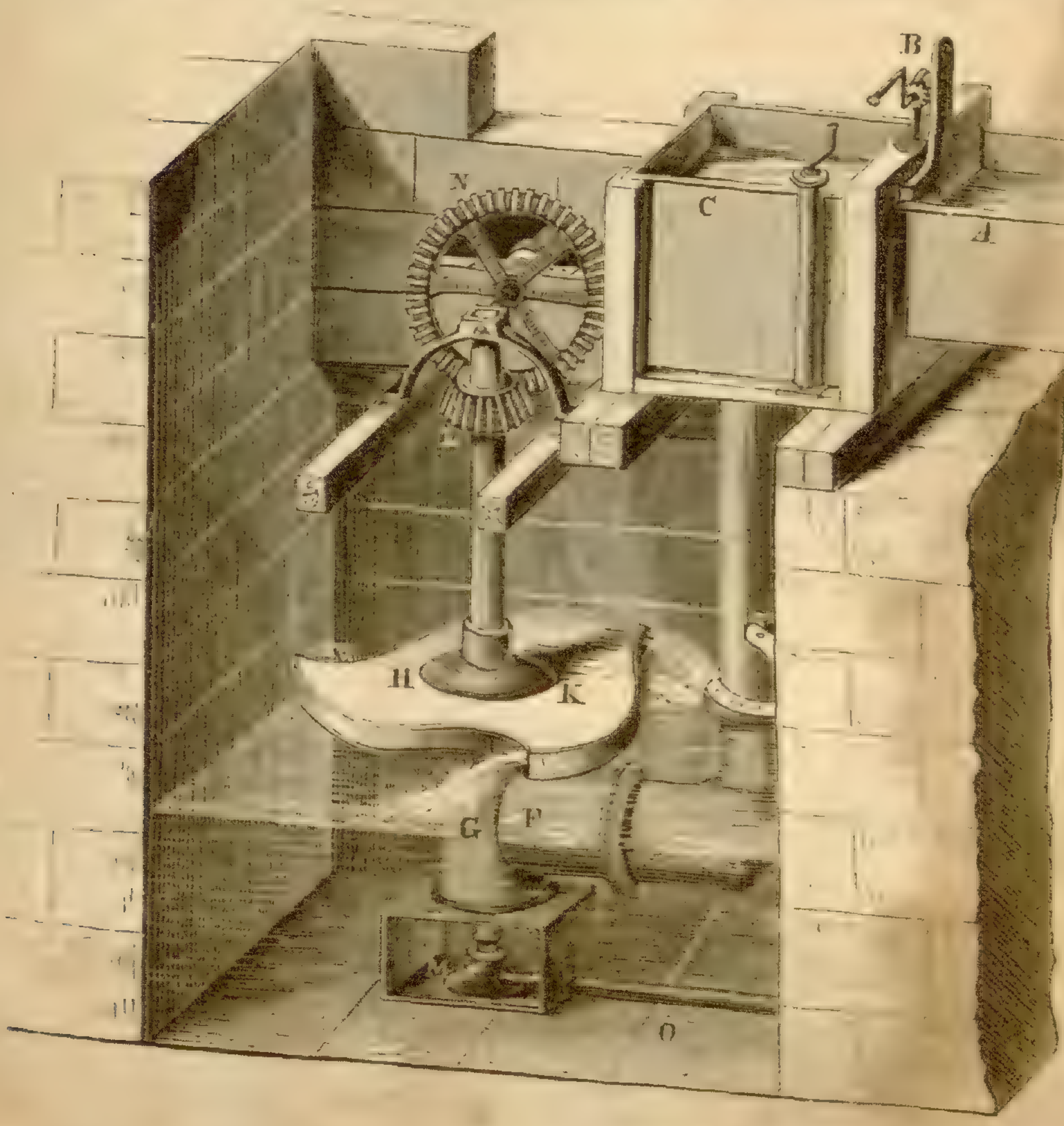

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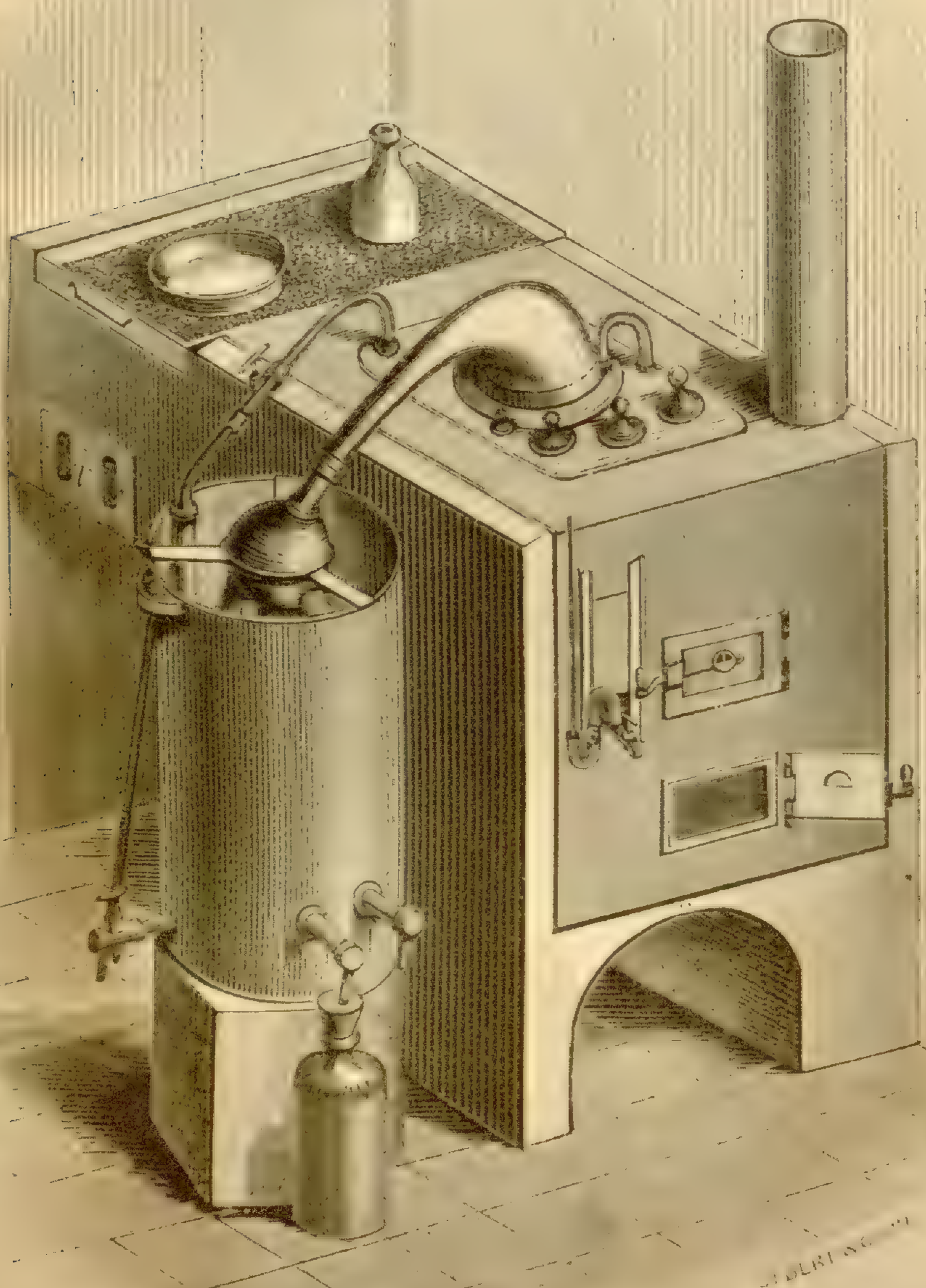

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XXVII.—*Notice of, and citations from a Voyage of Discovery and Research in the Southern and Antarctic Regions, during the years* 1839–43, by Captain Sir JAMES CLARK ROSS, R. N., Knt., D.C.L. Oxon., F.R.S., etc.: with plates, maps and wood-cuts. In two volumes, 8vo, pp. 366 and 447. Lond. 1847.

VOYAGES of discovery are among the most interesting and important of the adventures undertaken by man. They have been prosecuted in all ages since the introduction of the mariner's compass, and have been particularly numerous since the middle of the last century. England, France, Russia, and recently the United States, have sent forth exploring squadrons, as well as expeditions by land; their ships have traversed all the great oceans, and have pushed their daring voyages far within the arctic and antarctic circles, amid seas covered with floating icebergs, and in close proximity to the eternal barriers that repel any nearer approach to the frozen poles. The expedition under Capt. Wilkes, which certainly ranks among the ablest and most interesting of these undertakings, we have had frequent occasion to mention with warm approbation. It has done honor to our country, and will ever remain a memorable and illustrious event in its history.

Passing by other recent voyages, we propose for the present, to confine ourselves to the Antarctic Expedition of Sir James Ross; and as this work has not yet been reprinted, we may notice it somewhat in detail. This voyage arose from the recommendation of the eighth meeting of the British Association, held at Newcastle in August, 1838. The principal object proposed was the extension of physical science, especially in relation to terrestrial magnetism, to the importance of which the attention of the Association was invited by Lt. Col. Sabine, and it was enforced by

a committee consisting of Sir John Herschel, Professors Whewell and Lloyd, and Mr. Peacock. These gentlemen presented the subject to the attention of the British government in a series of resolutions adopted by the Association, recommending—

1. A coöperation with the simultaneous observations made and making in Germany and other countries—to be extended to various parts of the British dominions—especially Canada, Ceylon, St. Helena, Van Diemens Land, and the Cape of Good Hope.

2. These observations were proposed to include the direction, intensity and dip of the needle—also, the hourly changes, and on appointed days, its momentary fluctuations.

3. The observations to be made in high southern latitudes, between the meridians of New Holland and Cape Horn, were regarded as particularly important.

The subject was still farther enforced by the powerful influence of the Royal Society and its President, Lord Northampton, who recommended also the establishment of fixed magnetic observatories in various and remote places.

On the 8th of April, 1839, Capt. Ross was commissioned to take charge of the Erebus, a bomb vessel of three hundred and seventy-five tons, of great strength and containing capacity; the Terror of three hundred and forty tons, prepared in 1836 for the arctic seas, being then fitted up so as to be ice-proof, was placed under the direction of Commander Crozier. Each ship had a complement of sixty-four persons, and every provision was made for safety and health: ample means of every kind for accomplishing the objects and meeting the vicissitudes in prospect were supplied in the most liberal manner.

The council of the Royal Society drew up a report, making a small book of one hundred pages, containing a detailed account of every object of inquiry which the diligence and science of the several committees could devise, including geology, zoology, and botany. The most important scientific results of the expedition were transmitted to the Royal Society, and were consigned to their Transactions in the regular course of publication, only passing notices being given in the Narrative.

The Expedition sailed from the Thames on the 30th of September, 1839, and the 5th of October, they bade adieu to England.

In crossing the bay of Biscay in rough weather, they measured the height of the waves which did not exceed thirty-six feet. No bottom was found with from three hundred to six hundred fathoms of line.

Madeira.—Arrived at this island, they at once commenced their magnetic observations. By means of mountain barometers, they ascertained the height of Pico Ruivo to be 6096·08 or 6102·90 English feet, varying with the modes of computation. Captain Wilkes found the height to be 6237 feet above half-tide.

The pile of stones erected by the officers of Capt. Wilkes remained, but the notice attached had been removed.

An aurora borealis with colored streamers was observed beyond the limits of the atmosphere. Several kinds of tea plants were seen in a garden on a mountain, cultivated with many other Chinese plants; the flavor of the tea was excellent.

October 31.—A coming storm compelled the ships, suddenly, to depart; November 4, they saw the Peak of Teneriffe—landed their letters at Vera Cruz and bore away for the Cape de Verds, and passed the tropic of Cancer on the 8th.

The elevation of the plane of vapor was ascertained to be at about 2,000 feet in these tropical regions.

St. Paul's Rocks, lat. 0° 56′ N., long. 29° 20′ W.—These rocks are 500 miles from any continent, and are not in any part more than seventy feet high. There is a crater, according to Capt. Ross, who believes that they have been elevated by fire; but Mr. Darwin thinks them not to be of volcanic origin. They hardly exceed half a mile in circumference.

Soundings were obtained two-thirds of a mile from the rocks, with 300 fathoms of line, but at twice the distance 500 fathoms of line were not sufficient, thus proving the great steepness of the submarine mountain.

December 7th, *the magnetic equator was crossed*, in lat. S. 13° 45′, long. W. 30° 41′, with such precision that the magnetic dipping needles were horizontal at the same instant in both ships, being equally balanced between the northern and southern magnetic systems.

Capt. Ross had some years before seen the needle standing vertical over the northern magnetic pole, and now he looked forward with hope to the time when he should find himself over the south magnetic pole. The change of dip was very regular; at 280 miles north of the magnetic equator the dip was 9° 36′; at 292 miles south it was 9° 52′, the former corresponding to 2·05 minutes, and the latter to 2·03 for every mile of latitude. This large amount of change is confined to the vicinity of the equator; near the poles it requires an approach of about two miles to produce an alteration of a single minute of dip.

Trinidad was seen December 17. The island is a mass of volcanic material, in some parts 2000 feet high. The trap rocks exhibit very extraordinary forms. The Nine Pin rock rises perpendicularly from the sea in a beautifully proportioned column 850 feet high.

The trap rocks on shore influenced the magnetic needles so much as to render the observations useless, while those made on ship board were perfectly correct.

Rain from a clear sky, in a cloudless night, fell for an hour; dew point by Daniel's hygrometer 72°—temperature of the air 74°.

Sounding of the Ocean.—Capt. Ross, provided with a line of 3600 fathoms, or rather more than four miles long, on the 3d of January, 1840—in fine weather obtained soundings with 2425 fathoms of line, equivalent to a depression of 14,550 feet, (more than $2\frac{3}{4}$ miles,) and very little short of the elevation of Mont Blanc above the ocean. The line was capable of sustaining a weight of seventy-four pounds, and was furnished with swivels to prevent entanglement on its descent. The lat. was 27° 26′ S., long. 17° 20′ W., and only 45 miles N.W. of the place where a shoal was marked on a chart as having been discovered in 1701.

St. Helena, January 31, 1840.—An observatory was erected near the late residence of Napoleon; but owing to the magnetic influence of the volcanic rocks, no accurate results could be obtained, either on land or on board the ships. This proved to be a general fact with the volcanic islands which they visited.

The line of least magnetic intensity was several times passed by the ships in these regions, and by comparison with earlier observations, it appears to have moved northerly during the last fifteen years at the average rate of about thirteen miles per annum.

February 22.—Soon after dark a number of cuttle fishes sprang on board, fifteen or sixteen feet high over the weather-bow; several passed entirely across the ship, and fifty at least were found on the deck.

Waves. Feb. 29.—In a heavy swell the waves were twenty-two feet high, eleven above and eleven below the ocean level; the velocity of the undulations was eighty-nine miles an hour, and the intervals between the waves 1910 feet.

Soundings.—March 3, lat. 33° 21′ S., long. 9° E., soundings were obtained at 2677 fathoms—16,062 feet, or over three miles and one-fourth.

A current of cold water from the eastward passing round the Cape of Good Hope along the African coast, has been long suspected and its existence was now believed to be fully confirmed. Its average breadth is about sixty miles, with a depth of two hundred fathoms—the temperature at two hundred fathoms, sixty miles from the land, being 43°·5, while that of the surface was 61°. The atmosphere vapor, condensed into a cloud of mist, hangs over the stream. It extends only seven or eight miles south of the Cape.

March 17.—*Cape of Good Hope.*—The Cape proved very favorable for magnetic observations, as sandstone is the basis of the country; and every assistance was afforded by the British official residents.

April 11.—*Soundings were obtained* at one hundred and twenty-five fathoms on the Aguilas Bank; but after sailing seven miles on that course there were no soundings at three hundred and

twenty fathoms, and the next day none at six hundred fathoms; so suddenly does the water deepen to the south on leaving the bank.

April 13.—*The variation of the compass* increased to 30° W.

April 21.—*Prince Edwards Island* between 49° and 50° south. Near the East Cape, the lead brought up from eighty-six fathoms, fine sand, coral and corallines. The coast was composed of black, perpendicular volcanic cliffs, much worn by the action of the waves. High mountains in the interior of the island were partially covered with snow.

Penguins, in groups of many thousands each, peopled the shore, and some fur seals were playing in the surf. In Possession Island, one of Crozet's group, called also Penguin Island, the Penguins crowned all the ledges of its rugged shores. The surface rose into mountain masses of volcanic rock with curiously shaped pinnacles and no appearance of vegetation.

Swine in vast numbers occupy Pig Island, so called from its four-footed inhabitants, whose ancestors had been left there by Capt. Distance in 1834. In six years they had multiplied astonishingly, although vast numbers are killed by sealers for immediate use and for salting for their voyages. Goats also in considerable numbers were found on Possession Island, having been left there by American navigators.

On *East Island*, there was a party of eleven men engaged in hunting the sea-elephant, a gigantic seal; they had plenty of food and were contented. The tongue, flippers and part of the carcase of the sea-elephant are eaten by them. Their boots were made of the skins of the penguin, with the feathers turned inward. They were far more filthy than Esquimaux, their apparel being perfectly soaked with oil and smelling most offensively. They find abundance of rock-fish; and the eggs of sea-birds may in the proper season, be collected in boat loads. The egg of the albatross weighs over a pound. Wild ducks are so numerous that trained dogs capture them in any number when they are wanted.

This group of islands is of volcanic origin, and about the tops of some of the hills basaltic pillars were visible. East Island, although not more than three or four miles in diameter, rises at least four thousand feet, and the precipitous shores are several hundred feet in elevation. Off the capes there are detached rocks, pushing half a mile out to sea; one is called from its appearance the ship-rock, another the church-rock, and so on: and one west of the North Cape of Possession Island, is perforated, so that it is said a vessel may pass through it.

May 3.—Lat. 47° 17′ S., long. 58° 50′ E.—The first antarctic ice was seen, only twenty feet out of water, but giving strong premonition of coming scenes.

The albatross, cape pigeon, duck, petrel, and storm petrel in great numbers, gave cheerfulness to the solitary wanderings of the adventurers, and afforded a strong contrast to the dreary stillness of the tropical regions where not a sea-bird is seen except near the few islets, although the ocean abounds with proper food.

May 6.—*Kerguelen Island*, lat. 49° 20′ S., long. 39° 30′ E., was descried; the directions of Cook were relied on and found to be so accurate, that they sailed fearlessly and discovered this small rocky island, when they were almost close upon it; they anchored in Christmas harbor.

This island was discovered in 1772, by a Lieutenant in the French navy of the name Kerguelen, and for several years it excited much attention on account of its being supposed to be a part of a great southern continent. It is bounded by a succession of terraces rising to a height of more than one thousand feet, and Table Mount on the north is 1350 feet high, with the appearance of a crater on the summit. On the north side it has some very perfect basaltic columns beautifully arranged, and their ruins cover the sides and the bottom.

The work by Capt. Ross is fully illustrated by beautiful plates in harmony with its general style; and among them a view of Christmas harbor forms the frontispiece. This harbor has a circular figure, being walled in with a vertical colonnade of trap rock—the point of view from which the picture was taken being six hundred feet high.

On the south side of Christmas harbor is a huge rock of basalt, five hundred feet thick, resting upon an older rock at an elevation of six hundred feet, through which it appears to have burst. Between these rocks were found *fossil trees*, and one of seven feet in circumference was sent to England. The wood is partly silicified so as to scratch glass, and partly combustible, burning freely. A bed of shale six feet thick lay over some of the fossil trees and probably protected them from being carbonized by the molten rock, when it flowed over them. In the arched rock at the entrance of the harbor, fragments of wood much twisted and softer than the silicified wood, are enclosed in the trap—numerous seams of coal are found in the trap from a few inches to four feet in thickness, being thirty feet long in one place and one hundred and fifty in another, where it was in view. The trap rock is of a conglomerate structure, the enclosed fragments being excessively hard and ponderous.

Cumberland bay, a deep inlet of many miles, is bounded by trap rocks, in which are beautiful drusy cavities filled with fine quartz crystals. *Coal* is found in this bay also, in a seam one foot thick and ten feet long; the coal is black and glossy, resembling cannel coal, and does not soil the fingers. Another bed was two feet thick; it burned well and the crew cooked their provis-

ions with it. The superincumbent rock is amygdaloidal greenstone. Coal and fossil wood were found in various parts of the island. Along the basaltic hills the quantity of ruins was enormous, "forming in some places a steep slope of three hundred to five hundred feet down to the black edge of basalt on which the sea breaks."

The *vegetation* is scanty and is described in Hooker's *Flora Antarctica;* it is decidedly antarctic. At a little distance the island appears sterile; but on nearing the shores a belt of green grass is seen to be succeeded by an umbelliferous plant similar to the *Bolax* or "Balsam Bog" of the Falkland Island. Higher on the hills the vegetation exists only in scattered tufts, and almost ceases at an elevation of one thousand to twelve hundred feet. About one hundred and fifty species of plants were observed in all, eighteen flowering plants, three ferns, twenty-five mosses, ten Jungermannia, one fungus, the rest lichens and sea-weeds. The cabbage plant (*Pringlea antiscorbutica*) appears to be peculiar to this island. It was discovered during Capt. Cook's voyage and has proved a highly important vegetable, especially to seamen; it resembles the common cabbage, but contains a large proportion of essential oil which is said to be highly beneficial. It abounds near the sea and ascends to the summits of the hills. The heads are as large as a good cabbage lettuce. The root tastes like horse-radish, and the young leaves or heart, like coarse mustard or cress. The crews of the Erebus and Terror for one hundred and thirty days required no fresh vegetables but this, and for nine weeks it was regularly served out with the salt beef and pork, and during this time there was no sickness on board. Although Kerguelen Island is now destitute even of a shrub, the abundance of fossil wood proves that it was once covered with trees.

There are on the island two species of grass affording nutritious fodder for goats, sheep and pigs, but there are no land animals. Sheep landed by navigators throve wonderfully. The sea-elephants* and other seals formerly very numerous and constantly hunted, are nearly exterminated.

The whale fishery is prosecuted by many hundreds of ships along these shores. Edible fishes are abundant and many new species were found.

Fifteen species of sea-fowl were shot, petrel, penguin, gull, duck, tern, cormorant, albatross, &c. This is a favorite breeding place for the sooty albatross; although late in the season, several full fledged young birds were met with ready to commence their long flight over the Antarctic seas. Ducks were furnished in abundance for the table. The penguins although strong to the taste, made a rich soup resembling that of the hare.

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* See the Geology of the voyage, by Dr. Richardson and J. E. Gray, Esq.

Magnetic observations were fully carried out, although during sixty-eight days while the ships were in Christmas harbor, it blew a gale, generally with great violence; for forty-five days the establishment and observers were in danger of being carried into the sea.

Magnetic observations, May 29*th* and 30*th*.—The term-days previously agreed on for simultaneous observations in all the foreign and British observatories, that constitute the great system of magnetic coöperation, were here strictly attended to.

"It happened fortunately to be a period of unusual magnetic disturbance, so that the first days of simultaneous observations proved the vast extent and instantaneous effect of the disturbing power, affecting the magnetometers at Toronto in Canada and at Kerguelen Island, nearly antipodal to each other, simultaneously and similarly in all their strange oscillations and irregular movements." The hourly observations were made without a single break during the whole time the ships were at this island.

The tides rise and fall here not more than thirty inches, and the spring tides are generally less than two feet; the neap tide varies from four to twelve inches.

July 20, 1840.—The ships left Kerguelen Island for Van Diemens Land. Terrific gales and snow storms attended them. Once during a snow squall, the thermometer fell to 27°, although the sea remained uniformly at 36°; the vapor that rose from the water at that temperature, almost instantly froze as it passed over the ships, and kept them constantly enveloped in haze and snow.

Many meteor appearances were seen during a heavy gale, July 27; there was much lightning, and the barometer fell to 28·88; sheets of water broke athwart ships, flooding the decks—and July 30, Mr. Roberts, the boatswain, a man much valued, was swept overboard and drowned, notwithstanding the daring efforts to save him.

During these gales the Terror parted from the Erebus, and they did not meet again until their arrival at Van Diemens Land. Icebergs warned them to be vigilant during the long cold and dark nights of fifteen hours. The winds from the N.W. invariably brought thick weather and snow showers, while clear cold weather, with a rising barometer, attended the S.W. gales.

Magnetic observations were regularly continued during the whole distance of three to four thousand miles, from Kerguelen island to Van Diemens Land: this was effected by means of the excellent apparatus of Mr. R. W. Fox; the instruments commonly in use would hardly have enabled them to make a single observation. They, several times, crossed the isodynamic lines, and on August 6. found the maximum intensity to be in lat. 46° 44′ S., long. 128° 26′ E., being then 2·034 (of the table, p. 104, vol. i), and it diminished to 1·824 at Van Diemens Land.

The westerly variation gradually diminished during this run until August 8th, when in lat. 46° S., and long. 134½ E., they crossed the line of no variation and then the easterly variation as rapidly increased. "The line of no variation, which passes through Australasia, has undergone very little change of position during the last sixty years; and it seems probable that the variation on this spot is about as fixed as on the coast of America."* "We have also reason to believe that at the Cape of Good Hope where the westerly variation has been regularly increasing ever since about the year 1600, when the line of no variation passed through it, at the rate of seven and eight minutes annually, it attained its maximum in 1840."

A terrible storm, August 12th, tore their canvas into ribbons, but they arrived safely in the river Derwent, in Van Diemens Land, August 16th, and to their great joy found that the Terror had arrived the day before them. They remained there two months, and in that time established a permanent observatory called Rossbank by Sir John Franklin, the governor of the Colony. It is in lat. 42° 52′ 27·4″ S., long. 147° 27′ 30″ E., one hundred and five feet above mean tide level, on vast strata of sandstone. Lt. Shay and a party were left to make observations during the absence of the ships in the south.

The mean magnetic dip was 70° 40′ S., and the variation in May, 1841, 10° 24′ 24″ E.

The convicts, two hundred in number, who labored in the excavation of the foundation rock, and the erection of the fixtures, manifested great zeal, and volunteered to labor all night in order to finish the building in season for the observation day, August 27th; and before this time every thing was ready: the whole work, including the delicate adjustments of the instruments, was accomplished in nine days.†

Throughout the twenty-four hours of the 27th and 28th of August, a record was kept of observations in the three elements,

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* Barlow in Phil. Trans. for 1837, p. 71.

† In connexion with this residence in Van Diemens Land, a statement is introduced, respecting the comparative observations and merits of the Briti-h, French and American squadrons of discovery, under their respective commanders, Captains Ross, D'Urville and Wilkes. It is to be regretted that so honorable a man as Sir James C. Ross, and that too after an appropriate expression of generous sentiments, should have thrown out an imputation of intended interference in the line of discovery, which Capt. Wilkes has shown by reference to dates and documents, to be entirely without foundation as regards the American squadron (and we believe it has never been proved to be true, as regards the French); moreover the report is wholly untrue, that the British Expedition sailed over any part of the region where land was laid down by Captain Wilkes, the route of Captain Ross being too far to the eastward. But as these matters have been already discussed in the prints—(and in this Journal, vol. v, p. 288, ii series,) we do not incline to go over the ground again, but proceed with the more agreeable task of setting forth the valuable results obtained by the British Expedition as recorded in the interesting volumes before us.

made simultaneously by two magnetometers, once in every two and a half minutes.

November 12, 1840.—The ships sailed again for the south. The *aurora australis* was faintly exhibited about midnight of November 15, in lat. 45° 33′ S., long. 152° 45′ E.

Auckland Islands, lat. 50° 48′ S., long. 166° 42′ E.—These islands are situated between eight and nine hundred miles from Hobartown, (Van Diemens Land.) They were discovered in 1806. After contending with fierce winds from the land, the ships anchored and found a painted board commemorating the visit of D'Urville, March 11th to 20th, 1840, and claiming the discovery of "la Terre Adelaide,"* January 19th to February 1st, 1840, and the determination of the south magnetic pole. Also another board was observed, recording a visit by the U. S. brig Porpoise, March 7th to 10th, on her return from exploring along the antarctic circle, and the icy barrier.

An observatory was established here by Capt. Ross, lat. 50° 32′ 30″ S., long. 166° 12′ 34″ E. The magnetic dip was found to be 73° 40′ E.; the magnetic action of the rock however, rendered the observations of little value. On the passage from Van Diemens Land, there had been observed a gradual increase in the dip; but the first observation on land was two degrees, and the second eleven degrees in error. The rocks had a peculiar ferruginous appearance, and on presenting a fragment "to a delicate compass it turned round and round as swiftly as the hand could move;" it had also polarity, the position of the north and south pole being determined by the direction in which the rock had lain in relation to the magnetic meridian. They were obliged to rely upon the dip as observed on board the Erebus, which was sufficiently removed from the influence of the land, while the Terror was too much affected by the proximity of the diminutive Shoe island. Even at the distance of fifty feet, the needle was made to deviate 2°. Both Auckland and Campbell's islands are composed chiefly of basalt and greenstone, and Deas Head, a promontory of Auckland Island, exhibits fine basaltic columns 300 feet high, which are magnetic. Some of the hills are 1000 and 1300 feet high.

Vegetable productions.—As none of the mountains rise to the snow line, and there are few rocks or precipices, the whole land seems covered with vegetation. Some forests skirt the shores, then comes a broad belt of brushwood, and grass slopes rise to the hill tops. The forest is a dense thicket of stag-headed trees so guarled and stunted by violent gales of a boisterous ocean, as to shelter effectually a luxuriant under-growth of bright green feathery ferns, and several gay flowered herbs. The trees and shrubs of the north are wanting.

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* A part of the great Southern continent.

The woods consist entirely of four or five species of trees or large shrubs, as follows:—*Metrosideros lucida*, a tree with a short thick trunk, allied to the classical myrtle.—*Dracophyllum longifolium*, with a black bark, slender and neat branches and grassy leaves.—*Panax simplex.*—*Veronica elliptica*, a plant of Tierra del Fuego and New Zealand.—*Coprosma fœtidissima*, leaves very fetid, especially when bruised and drying.

The most beautiful plants are found upon the hills—the vegetation being very luxuriant. Eighty flowering plants were found, and fifty of them new.

Mosses, Lichens, Hepaticæ and sea-weeds—more than two hundred, and most of them new. A tree fern was brought on board three or four feet high, with fronds between three and four feet long. The proportion of monocotyledons to dicotyledons was as one to twenty-two.

The domestic pig introduced several years ago and now in a wild state, is the only quadruped, and has greatly multiplied; their food is the Arabia polaris. The birds have come from New Zealand; of land birds there are only seven or eight species.

The albatross breeds in considerable numbers on the tops of the cliffs on a small mound of earth. Its nest is built by the joint labors of both the male and female; it is composed of dry grass and leaves matted together, and is about six feet round at the base and two feet high. Like most of the petrel tribe, the albatross lays but one egg, it is pure white and weighs from fifteen to twenty-one ounces. Two eggs were found in one nest, in only one instance out of one hundred.

Campbell Island was discovered in 1810 by Hazelburgh in the Perseverance, the island is about thirty miles in circumference. The ships found a good harbor called Perseverance, after the ship of the discoverer. It was capable of containing one hundred ships although somewhat shoal in some parts. In entering it they encountered gusts of wind which came down from the heights with astonishing force. This sudden rush of strong winds is characteristic of all the islands in this latitude, and is the more dangerous on account of the light and baffling winds which occupy the intervals between the squalls. At Campbell Island the trees are prostrated by the prevalence of the westerly winds.

Campbell's Island is situated 120 miles to the southward of the Auckland group, but contains fully as many native plants. The whole number of species of plants in the islands, south of New Zealand, is about one hundred, and of these only one-fourth are found in New Zealand, one-thirtieth in Van Diemens Land, and one-sixth in Tierra del Fuego. Campbell Island possesses none of the pines and beaches of New Zealand. It has no land birds.

Departure for the Antarctic.—Fifteen months had elapsed since the expedition left England; but the ardor of the company had in no degree abated, and on December 17th, 1840, they set sail steering directly south, with a moderate breeze increasing to a gale.

In lat. 57° 52′ S., long. 170° 30′ E., the temperature of the water at 230 fathoms was 39°·5, while at the surface it was 42°. It was midsummer in that hemisphere, but the mercury did not rise above 46° at any time in the day.

December 27—the mercury was at 29° all day; many whales were seen; soundings were not obtained at 600 fathoms, and the temperature of the ocean at that depth was 39°·7.

The first iceberg was seen in lat. 63° 20′ S., and others came quickly into view. They were large and solid, with vertical cliffs all around, and their tabular summits varied from 100 to 180 feet in height; large masses were continually falling from them and forming long trains of floating fragments to leeward.

Whales in great numbers were seen—some sperm, but chiefly the black whale,—and they were so tame that any number of them might have been killed. The *Clio borealis* and *Argonauta arctica* were all around, and doubtless here as in the north, formed the food of the whales.

Icebergs became numerous—and in the night amid showers of snow, the first notice of their proximity was given by the roaring of the waves against their precipitous sides.

December 30.—Having crossed the track of the Russian navigator, Bellinghausen, in lat. 64° 38′ S., long. 173° 10′ E., bottom was struck with 1560 fathoms.

January 1, 1841.—New year's day was kept joyously as Christmas had been, and additional provisions and warm clothing were dispensed to the people. The scene was highly exciting, for having now crossed the Antarctic circle, they were fully involved in the pack ice, among whose innumerable masses, whales were seen cruising, and the white petrels were flying about in great numbers.

January 2.—*A berg was seen with a large rock upon it* and nearly covered with mud and stones; the rock when examined proved to be volcanic. On the 4th, in a clear blue sky, the sun illuminated a great number of bergs of strange and curious forms, reflecting its brilliant rays in every beautiful variety of color, and forming, as the ships pursued their devious way among them, a scene of much interest and grandeur.

January 5.—In lat. 66° 55′ S., long. 174° 34′ E., nothing but ice was visible, among which they navigated freely, forcing opposing barriers which only ships fortified as these were could have withstood. Progress was made till they were sixty or seventy miles from its northern edge, and it was fluctuating with the billowy motion, as in thick showers of snow they advanced farther into it. Many seals were seen basking on the ice, and penguins whose

cry the sailors had learned to imitate, responded and followed the wake of the ships in increasing numbers, playing about like porpoises.

During the following three days the ice became more packed, and slow progress was made. In a calm, magnetic observations were made on a cake of ice, which agreed with those on board the ships.

January 9.—They had forced their way into a clear sea; a gale ensued, but there were no icebergs, and it was evident that there was an open space of considerable extent.

January 10.—A violent storm subsided, no ice was visible. They were in lat. 70° 23′ S., long. 174° 50′ E., and the magnetic dip was 85°.

The magnetic pole was now the object of their eager search, but instead of it, while steering south, they discovered land. The *Antarctic Continent* rose in lofty peaks entirely covered with perennial snow; it stretched S.S.W. to S.E. by S., and appeared to be 100 miles distant. They named it Victoria land. Capt. Cook's highest latitude, reached in 1774, was 71° 15′, and this the ships had now attained. As they advanced fifteen leagues towards Mount Sabine. (so named by Capt. Ross after his early friend and patron,) they discovered other mountainous regions extending to the right and left. On the 11th, within two leagues of the shore they observed it lined with heavy pack ice and could find no place to land. A remarkable projection of high dark cliffs was supposed to be volcanic; it was strongly contrasted with the rest of the snow-covered coast, and other rocks several miles to the north showed their black summits conspicuously among the white foam of the breakers. Soundings were made at 160 fathoms and the lead brought up volcanic stones.

The lofty peaks of two magnificent ranges of mountains were covered with eternal snow, and rose seven to ten thousand feet above the ocean. The glaciers that filled the intervening valleys descending from near the mountain summits, projected in many places miles into the sea, and terminated in lofty perpendicular cliffs. In a few places the rocks broke through their icy covering, by which alone they were assured that land formed the nucleus of this, to appearance, enormous iceberg.

Mount Sabine, by several measurements, was found to fall a little short of ten thousand feet, and the other mountains were from seven to nine thousand.

Position of the magnetic pole.—The dip had increased to 86° and the variation amounted to 44°. The magnetic pole was, therefore, inferred to be in 76° S., long. 145° 20′ E., and distant about 500 miles S.W. from their position. The interposition of the land prevented their direct approach to the magnetic pole, and they determined to proceed to the south in the hope of penetrating farther in that direction.

The commanders of the ships with some of their officers, coasted along the shores defended by projecting ice, on which a heavy surf was breaking. With no small peril they landed on an island, to which they gave the name of Possession Island, and found themselves on a beach of large loose stones and stranded ice. In the name of their sovereign they took possession of the country with the usual ceremonies, and no one will ever dispute the right to this region of eternal winter; honor alone is concerned. Possession Island is in 71° 76′ S., long. 171° 7′ E. It is composed entirely of igneous rocks, and is accessible only on its western side. There was no vegetation, but innumerable multitudes of penguins completely and densely covered the entire surface of the island. With their beaks they vigorously attacked the intruders as they waded through their ranks. An insupportable stench arose from the deep bed of guano which had been forming for ages, and which, could it be safely approached, may hereafter be valuable to Australian agriculture. With difficulty they regained their ships; a dense fog, in a few minutes, cut off their view and a gale supervened which obliged the ships to stand off to the open sea. Several days of heavy winds followed, and great numbers of whales were sporting about unmolested, and devouring the molluscous and other marine animals which abound in these seas. In these regions the whales dive under the ice and then come up in the openings to blow.

January 15.—Magnificent views of the mountains were enjoyed with great enthusiasm; the weather was fine and the sharply pointed snow-clad summits, were, by a rough measurement, ascertained to be twelve to fourteen thousand feet high. A heavy swell tumbled in upon this ice bound coast, the ship sometimes pitching her bowsprit under water. Whales and penguins still attended them in great numbers.

One of the icebergs turned completely over and brought up a new surface covered with earth and stones, and in all respects it so resembled an island, that only landing upon it could convince one to the contrary. No harbor could be found for making magnetic observations.

January 16.—They were in lat. 72° 12′ S., and as they proceeded southward, new portions of land came into view; the mountains, seen at a distance of ninety miles, reflected from their icy mirrors, every tone and modification of light.

January 18.—They were in lat. 72° 57′ S., long. 176° 6′ E., and obtained soundings in 230 fathoms; in their nearer approach to the shore they had been found in from sixty to ninety fathoms; as they proceeded, they became 184, 194 and 180 fathoms.

January 19.—In a calm of two hours they dredged at the depth of 270 fathoms and brought up a block of grey granite, of which the usual constituents, quartz, feldspar and mica were

large and distinct, with apparently a fresh fracture as if recently detached. It was probably deposited by an iceberg.

Various other granitic and volcanic masses were raised, and also *living coral;* various corallines, flustræ and marine invertebrate animals were obtained, proving that the bottom of this antarctic sea is affluent with life. Very fine weather and fair winds enabled them to push on rapidly, and at noon January 20th, they were in lat. 73° 47′ S., long. 171° 40′ E.

A high mountain was now seen, believed to be higher than Mount Etna, and it was called Mount Melbourne. The dip now amounted to 87° 39′ in lat. 74° 15′ S., by reckoning, or 74° by observation.

January 22.—At midnight the sun was shining in the south at an altitude of about 2°, in a perfectly clear and serene sky, which above was of a most intense indigo blue.

Dredging in 300 fathoms for two or three hours, brought up many corallines, animals, sand, mud, and small stones, with some entirely new forms of animal life, existing at a depth of nearly 2000 fathoms. Some species that were fished up are common to the arctic and antarctic seas, and if they passed from pole to pole, it must have been through the tropics; but they could not exist in those seas except at a depth of nearly 2000 fathoms. At that depth they might pass from the arctic to the antarctic circle (supposing they could endure the pressure) without a variation of five degrees of temperature, "whilst any land animal at the most favorable season, must experience a difference of 50°, and in the winter not less than 150° of Fahrenheit."

January 22.—The second instance occurred to-day of a rise of the barometer above the mean pressure for these latitudes, followed by a gale of wind and a snow storm. The latitude reached was 74° 20′ S., the highest that had been attained by man, and was the occasion of a festive celebration on ship board.

January 23.—The rising of the barometer during a gale was again observed; it rose to 29·33 at 4 A. M. The land was again in view, but they did not attempt to force a passage to it as they still hoped to reach the magnetic pole by a circuitous route, as the dip had increased to 88° 10′. The mountains called Melbourne and Monteagle were here seen conspicuous, the former crowned by what appeared to be an immense crater, the latter by a pointed summit.

January 26.—In a clear sea, midsummer of this climate, the thermometer was at 24° to 25°, and in heavy weather the spray froze so as to encumber the bows and the rigging. The dip had increased to 88° 33′, so that the magnetic pole was now only 174 miles W. by S.

January 27.—Lat. 75° 48′ S., long. 168° 33′ E., dip 88° 24′, variation 80° 50′ E.

Franklin Island.—With extreme difficulty and peril, Capt. Ross with some of his officers landed upon an island whose icy cliffs, lashed by the surge, rendered a foot-hold hazardous in the extreme, and one of the officers slipping between the boat and the rock was near being crushed and drowned.

This island is about twelve miles long and six broad, and is situated in lat. 76° 8′ S., long. 168° 12′ E.; the rocks are entirely igneous, the cliffs five to six hundred feet high, wholly without vegetation—not even a lichen or sea-weed. Still the white petrel and rapacious gull nested among the ledges, and several seals, but no whales were seen.

January 28.—*An active Volcano, Mount Erebus.*—The lofty land which had been seen the day before, "proved to be a mountain 12,400 feet high above the sea level, emitting flame and smoke in great profusion; at first the smoke appeared like a snow drift, but as we drew nearer, its true character became manifest." The discovery of an active volcano in so high a southern latitude, was justly regarded as a subject of great geological interest, proving as it does, that the antarctic as well as arctic snows and ice-mountains have no influence towards extinguishing the fires that rage beneath, and which, ever and anon, within the polar circles of the opposite hemispheres, burst through the frozen zones and flash upon the ever wintry skies of the coldest regions of the earth. The newly discovered volcano was called mount Erebus, while mount Terror was the name assigned to an extinct volcano to the eastward, little inferior in height, being 10,900 feet high.

Magnetic dip 88° 27′ S., variation 95° 31′ E., being south of the magnetic pole, the ice preventing an access to it. An icy barrier of 150 to 200 or 300 feet high, stretching along many miles, debarred any farther progress in that direction, although the commanders had appointed a rendezvous in 82° S.

"At 4 P. M. mount Erebus emitted smoke and flame in great quantity, producing a grand spectacle. A volume of dense smoke was projected at each successive jet with great force, in a vertical column 1500 and 2000 feet above the mouth of the crater; when condensing, first at its upper part, it descended in mist or snow and gradually dispersed, to be succeeded in about half an hour by another splendid exhibition of the same kind, although the intervals between the eruptions were by no means regular. The diameter of the column of smoke was between 200 and 300 feet, as near as it could be measured. Whenever the vapors cleared away, the bright red flame that filled the mouth of the crater, was clearly perceptible; and some of the officers believed that they could see streams of lava pouring down its sides, until lost beneath the snow which descended from a few hundred feet below the crater, and projected its perpendicular icy cliffs several miles into the ocean."

Mount Terror being much more free from snow, shewed numerous little conical crater-like hillocks, each probably (like those on the flanks of Etna) once in action. Lofty ice cliffs, probably over 1000 feet in thickness, solid without a fissure, and presenting vertical walls to the waves which dashed their foam high against them, stretched away interminably to E.S.E., and the ships sailed along them more than 100 miles without any prospect of passing around them. The latitude was now 77° 46′ S., longitude 176° 43′ E.

The magnetic dip had diminished to 87° 22′ S., proving that they had passed beyond the magnetic pole, and the variation was 104° 25′ E. Soundings were obtained in 410 fathoms with two feet of soft green mud; temperature at 300 fathoms, 34° 2′, in the air 28°; in summer the air and the water seldom differ more than three or four degrees.

A petrel wounded by a shot, falling in the water, was immediately torn to pieces by its companions.

At midnight the lat. was 78° S., in 180° E. long.

Magnetic irregularities.—In lat. 77° 6′ S., long. 189° 6′ E., the dip had diminished to 86° 23′, the variation decreased from 96° E., to 77° E., and then again increased to 16°. It appeared to be one of those extraordinary magnetic points first observed during Sir Ed. Parry's second voyage to the Arctic seas near the eastern entrance of the Hecla and Fury straits.

The highest latitude attained this season was 78° 4′ S., and all progress farther south was prevented by a barrier of ice 160 feet high, and extending in one unbroken line 250 miles.

(To be continued.)

ART. XXVIII.—*On the Fundamental Principles of Mathematics*; by STEPHEN ALEXANDER, Professor of Mathematics and Astronomy in the College of New Jersey.

(Continued from p. 187.)

Of Positive and Negative Signs, and a Particular Case of Imaginary Values.

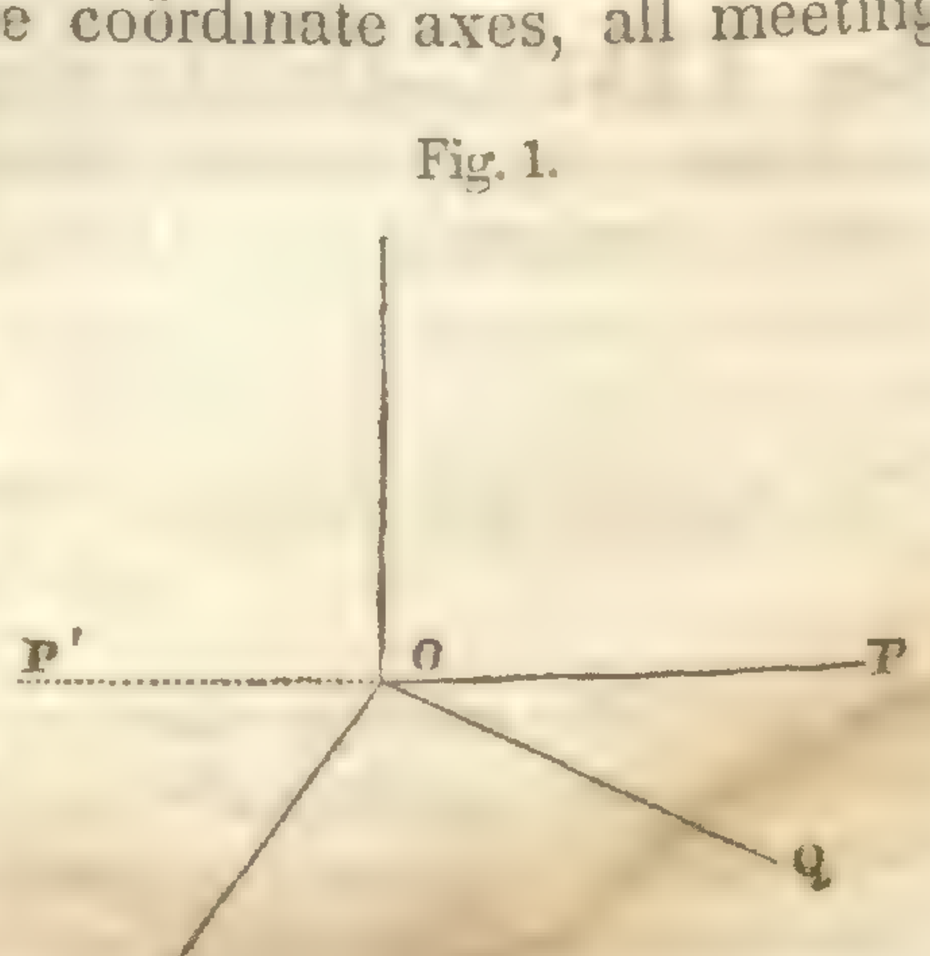
(17.) The consideration of the algebraical signs of quantities seems to be next in order, after what has already been exhibited, with regard to their division; for the relative greatness of the portions obtained, and the *manner* in which the greatness of the quantity will be affected by that of another in any given case of combination, will depend upon their respective signs; while neither the absolute, nor yet even the relative greatness of the quantities, will be affected by those signs.

Thus -2 indicates the subtraction, or at least the negative relationship, of *neither more nor less* than $+2$ (the negation of neither 3 nor 1 would answer the purpose) and $-Q$ indicates the subtraction, or at least the negative relationship of *as much as* $+Q$, *and no more.* In neither case can one of these quantities produce in a like combination a greater or a less effect than its own negative would produce; but that negative in such a combination (*because* it is *negative*) will be *destructive* to *precisely the same* extent to which the positive quantity is *constructive.* Hence, a negative quantity ($-Q$) cannot be regarded as being *in fact* less than *nothing* (i. e., (14) as less than the *zero of its own species*), but only as being *in effect* less than the zero of the species, in one particular respect; viz. *that very respect, in which the other quantity* ($+Q$) is *positive.* For *the zero* is *nothing* in that *specific* respect; while the negative quantity ($-Q$) is precisely as great indeed as $+Q$, but of an opposite *character* in the *very respect* in which $+Q$ is positive; insomuch that $+Q$ would be precisely destroyed by $-Q$; i. e., annihilated or reduced to *the zero of the species.* Or (as viewed in the opposite direction) $+Q$ would be precisely adequate to the destruction of $-Q$, reducing *it* to *the zero;* and a second similar introduction of $+Q$ would, in place of this last result of *the zero*, give $+Q$ itself: or, it appears, that $-Q$, in *the very respect* in which $+Q$ is positive, is *in effect*, as much below *the zero of the species*, as $+Q$, in the positive sense, is above it.

Similar principles will be applicable to the results of like combinations of other quantities with the respective quantities, $+Q$ $-Q$ and *the zero;* the respective results being represented by $+fQ$, no result, or *zero* (*of the same species with* $+fQ$,) and $-fQ$.

In the determination of the position of a point in space, reference, as is well known, is made to three coördinate axes, all meeting at one point—the origin. If from this origin O, we measure outward upon any of the three axes, we naturally mark the measured length as positive; since it increases as we proceed in that direction in space. If we measure from P toward O or P′, any distance less than PO, the quantity thus measured will thereby be taken from PO or will have an effect, the negative of the previous increase. If we thus measure from P a distance equal to PO; this distance will extend to the origin; and PO will be subtracted from itself, leaving no remainder; i. e., PO will be reduced to a point, or the *zero of*

Fig. 1.



length. If (still in the same direction) we measure from P a distance such as PP′, greater than PO, the farther extremity of the line so measured will extend *beyond* O to P′, i. e., to a distance equal to the excess of PP′ above PO; or the attempt to subtract from PO a quantity *greater than itself*, will result in a *negative* remainder equivalent to the excess of the greater quantity PP above PO; and this remainder will extend from O itself, in the direction *opposite* to that of OP. If PO = *zero*, the *whole* of PP′ will in this manner, extend from O in the negative direction.

The negative quantities thus originating are, in all the respects specified, strictly analogous to those which present themselves when the attempt is made to subtract 7 from 4, or 9 from 6, or, in general, the numerical quantity n from q, when n is greater than q;* the differences in the results of such subtractions being no other than those which must exist in the case of quantities of another species.

The same reasoning will apply to distances measured, in like manner, upon either of the other axes. Hence distance outward from the origin, in the direction first assumed, will in any case be naturally positive; and distance in the opposite direction, negative; and will be exhibited in its *isolated* as well as negative character, when measured in that direction, beginning at the origin.

These conclusions being independent of any particular inclination of the axes among themselves, will apply to the case of three axes the sum of whose three angles—that of first axis with second, second with third, and third with first—differs scarce at all from four right angles; and this, whether those three axes be situated on the one side or the other of a given plane of reference, passing through the origin O. As, therefore, the conclusions referred to will be applicable, however near the state of things may approach to that in which the three axes would be all in one plane, and this, on either side of that state of things as a limit; these same conclusions must be regarded as true in the case of that limit itself: or direction from the origin outward must be regarded as positive, whichever of the three axes may be employed to indicate it, and the contrary direction be regarded as negative, *even when carried beyond the origin by excess of distance extended in that direction:* the three axes being moreover all in the same plane.

As, moreover, the conclusions, from first to last, are independent of any fixed direction of one or more of the axes, they will all be alike applicable to any other three axes, which like OQ do not coincide with any of the first three; direction from

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* The view here presented will be found to coincide with that of *M. Faure*—"*Essai sur la Théorie et l'Interprétation des Quantités dites Imaginaires. Premier Mémoire*, (16.) *a Paris*, 1845." As M. Faure moreover intimates [*Essai, &c.*, (19.)], the distance subtracted from OP may be regarded as measured *negatively* from a *new origin* at P; precisely as OP′ is measured *negatively* from O.

the origin outward being still positive and the contrary negative, &c., in the case of any such axis; all the six axes being moreover in the same plane. What has thus been extended from the case of three axes thus situated to more than three, may in like manner be extended to any number of axes however great. Hence direction outward must be regarded as positive on any and every straight line drawn from the same origin, in the same plane, and the contrary direction must be regarded as negative, even when it extends, *after that manner, on the contrary side of the origin.*

We have, thus, exhibited *the foundation for the analytical necessity of regarding a radius, or a radius-vector, as positive, when measured outward from the centre, or pole; but negative when measured in a contrary direction, even when, after that manner, it is regarded as extending across or beyond that centre, or pole.*

(18.) The doctrine of "imaginary quantities" would be next in order; but this, of itself, would furnish matter for an entire dissertation; if it were even advisable to enter upon the consideration of a subject, so much and so often discussed.* It may not however be amiss to advert to one or two results of analysis which seem to admit of explanation, by a reference to the principle, that imaginary quantities, occurring in a geometrical investigation, may sometimes have a possible existence out of the plane of reference. Two equations first discovered by Euler,

$$\text{sin. } x = \frac{e^{x\sqrt{-1}} - e^{-x\sqrt{-1}}}{2\sqrt{-1}}, \text{ and cos. } x = \frac{e^{x\sqrt{-1}} + e^{-x\sqrt{-1}}}{2},$$

when transformed, by substituting for the real arc x, the imaginary arc $x\sqrt{-1}$, give, respectively,

$$\text{sin. } (x\sqrt{-1}) = \frac{e^{-x} - e^{x}}{2\sqrt{-1}}, \text{ and cos. } (x\sqrt{-1}) = \frac{e^{-x} + e^{x}}{2}.$$

Here the cosine is real, though the sine and the arc are both imaginary. This seems to arise from the fact that the cosine might, *in effect*, be found in *the common intersection* of the plane of the imaginary arc $x\sqrt{-1}$, and that of the axes of reference. It, therefore, has a real value; while the sine and arc, being both out of the plane of the axes, are imaginary. This being admitted, the secant of the real arc (i. e., the arc whose cosine has this real value) will $= 1 \div$ by the value of the cosine; while the secant of the imaginary arc having the same cosine must, it would seem, $= \sqrt[n]{-1} \div$ by the value of that cosine: unless the imaginary arc were reduced to the limit of 0°, or 180°, or 360°, &c.; when it would be terminated in the plane of the axes: when also its sine must $= 0$.

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* See among others, the "Essai" of M. Faure, (already cited in (17.).)

Of Infinites of Various Descriptions.

(19.) (*a.*) We shall designate a quantity as being *absolutely infinite;* if it be so great as to be *utterly boundless or destitute of any limit.*

This is the case with "absolute space;" which whether we regard it in a direction forward, or backward, or upward, or downward, or sidewise, or obliquely, is, in any and every direction, positively boundless or absolutely infinite.

So too, far back as the imagination can extend—antecedent to all ages past, antecedent to the existence of all created beings or things—we still behold, self-sustained on the throne of his adorable perfections, the GREAT FIRST CAUSE; who being the very origin of the first beginning, HIMSELF has none; but ever was, as now, "*from everlasting.*" It is in this underived antecedent, this perpetual precedent, of the *Divine Pre-existence*, that we find the realization of *Eternity Past.*

For also beyond the ages to come—unmeasurable though they may be "by the flight of years"—must still endure the ceaseless and unalterable being of HIM "who alone hath immortality" underived: and, *in that*, is Eternity Future. Yet what mental vision shall penetrate the "clouds and darkness" which surround the Divine Pre-existence; and inform us how it was, that, in Eternity Past, time e'er began. Or—fixing its unfaltering gaze upon "the light inaccesible" which covers, as with a veil of "glory," the designs and capabilities of the future—say what means the duration of an immortality once begun in his presence? Yet is it the combination of both these, of that eternity which always was, and that which "ever shall be"—nothing less than this, nothing short of it—that constitutes *the absolute infinite of duration!* It is the inexhaustible fullness of the being of HIM "who inhabiteth eternity," in its twofold sense; having ever been, as now, "*from* everlasting *to* everlasting."

(*b.*) We shall designate a quantity as being *specifically infinite*, if it be as boundless as those already described, *in certain respects only.*

Thus if a straight line be without termination, in either direction, from a point which might be assumed in that line, such a line will be specifically infinite; viz., in length—in which respect alone a line can be great or small. In this same respect might a surface be said to be infinite, on which such a line could exist, or the solid within or on which such a line would be possible: whatever might be the other dimensions of either the surface or the solid.

[If a line, alike interminable, were any where curved, such a line must be regarded as *longer* than the other; since it would intrude upon what may (by indulgence) be termed the *breadth*

of absolutely infinite space, as well as extend through what, for want of a better term, must be called its length.]

A surface without border would be specifically infinite in length, breadth, and a contiguous and plane superficial area.

[A surface without border and altogether plane, must, notwithstanding, be regarded as less than another surface, which though alike without border, yet deviates any where from a plane; since the latter not merely extends through all space in every direction which can be called length and breadth, such as exist upon a plane, but also encroaches upon what we may, in such a comparison, term the *thickness of space.*]

The quantities here characterized as specifically infinite are innumerable; and some may be parallel to one another: while, in so far as we can discern, there is but one absolute space; i. e., *one absolute infinite of extension.* So also there is but *one absolute infinite of duration.*

(*c.*) We shall designate a quantity as being, in comparison with another, *relatively infinite;* if the ratio of the quantity to that other be too great to be expressed by any assignable number, however large.

Any assignable number, however large, may be exceeded by the continued addition of the number 1 to itself; and then again to the sum, &c. &c.; and the like must be true with regard to any series or aggregate of the units of any species; when the number of units is assignable. But if, instead of continually adding the original unit, or its equivalent, we take its double, and of that product *its* double, &c. &c., and continue the process of successive doubling, until the *number* of such individual *processes* is as large as any number which we can assign; the aggregate will far exceed that obtained by successive additions, repeated as often.

For in the one series, the quantity to be added, at each successive step, is constant; so that if Q denote the original unit, the aggregate of the series or

$$S = Q + Q + Q + \&c. \ldots\ldots;$$

but in the process of continued doubling, each term consists of the aggregate of all that *preceded*, added to as *much* as itself; and therefore the sum of such a series, or rather the resulting aggregate,

$$S' = Q + Q + (2Q) + (4Q) + \&c. \ldots\ldots;$$

the terms after the second continually increasing. If then the number of *terms* in each series be as great as any that we can assign, the number of *times* the original quantity Q contained in the aggregate of the second series will be *too great to be assigned;* and will in any case exceed the number of units such as Q, which we may assign to the first series, however great that num-

ber may be. An aggregate such as S′ would then be relatively infinite in comparison with Q.

The like must, *a fortiori*, be true, if, in any or all of the processes of successive multiplication, the multiplier were more than 2; so that the multiplicand would be more than doubled.

If, by an inverse process, there were taken from Q its half, and then from the remainder its half, &c. &c., a sufficient number of times, we should, in the end, obtain a quantity so small, in comparison with Q, that no multiplier of it could be found sufficiently large to reproduce as much as Q.

For in this case, if the *number* of individual *inverse processes* were equal to that of the direct processes in the former case, and L be the last remainder; then, beginning with L, we must, in effect, repeat the process of continued doubling as often as before, in order to reproduce as much as Q; or Q will itself be relatively infinite in comparison with L; or L will be "an infinitesimal" in comparison with Q.

The like must be true, *a fortiori*, if at any step in the process, more than half were removed.

As, moreover, Q is relatively infinite in comparison with L, and S′ again relatively infinite in comparison with Q; so again, by continued doubling, beginning with S′, might another aggregate be obtained, which would be relatively infinite in comparison with S′, &c. &c. On this it is unnecessary to dwell; as one mode of exhibiting the differential calculus, owes its peculiarity to the employment of quantities such as these.*

It is important however to observe, that this description of infinity is the only one which can be predicated of *number*, *velocity*, *mere mechanical force*, &c. &c.

For no number can be so great, that a sum of units *might not exist*, (1.), which should exceed that number.

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* It may not be amiss, here, to notice an argument against the consistency of the results of mathematics which may be thus exemplified. An inch may be divided, and the remainder subdivided, &c., by the process already explained, and thus the infinitesimal of an inch obtained; and the aggregate of all such infinitesimals into which the whole inch might be divided, would be equal to the inch itself. Now if the inch were passed over by a moving body, the passage over each infinitesimal would occupy some portion of time. But the number of such portions of time would be infinite; since the number of the infinitesimals of the inch is infinite. Hence (says the objector) it must require an *eternity* for a body to move over an inch—which is absurd. The conclusion is indeed absurd, but *that* conclusion follows not from the premises. For as the inch is relatively infinite, i. e., infinite *in comparison* with its infinitesimal, in the restricted sense of relative infinity; but still finite and capable of measurement by a comparison with other standards; so the time requisite to pass over an inch with a uniform velocity, will be relatively infinite, i. e. in comparison with the time in which the infinitesimal of an inch would thus be passed over; while it also might be finite and capable of accurate measurement by a comparison with another standard. This portion of time then could only be called a *relative* eternity; if that were not an abuse of the term. If the whole inch were traversed in a minute, this relative eternity would endure but for a minute; while it would still be true that the infinitesimal of an inch would be traversed in an infinitesimal of that minute.

And no velocity could be so great, that the body moved would be in two places, at the same instant; for that would contradict what all experience has shown to be true of the nature of body. Hence the transfer of a body from one place to another, however rapid, must occupy some time: and it is mathematically *supposable*, and, for aught that can be discerned, physically possible, that the body might be made to pass through or over a greater distance in the same time; i. e., any velocity, even that which is too great to be measured, might admit, it would seem, of an increase.

So also, however great a mechanical force may be applied in any case; another might (for aught that can be discerned) be added to and combined with that force.

(20.) It may be observed in brief that the three descriptions of infinity obtain respectively, thus:

1st. *Absolute infinity*, when the quantity is so great that there is no limit to it.

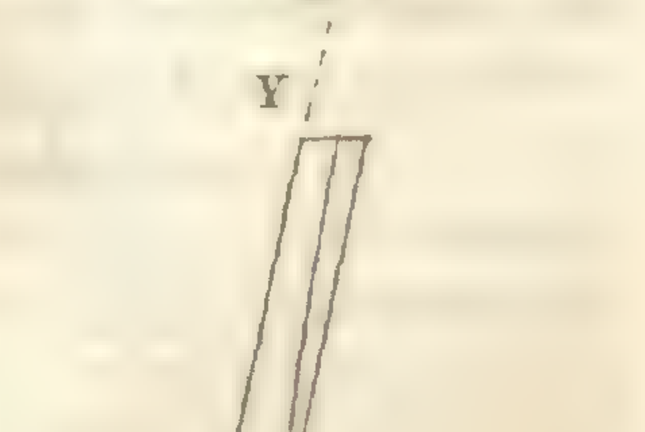
2d. *Specific infinity*, when this boundlessness exists in certain respects only.

3d. *Relative infinity*, when the one of two quantities of the same species is too great to be measured by the other.

Of Finite Quantities which are specifically infinite in one Dimension.

(21.) The results of the *Integral Calculus* have long since indicated that certain areas whose *limits* in part are lines *interminable in one direction*, may yet themselves be finite. Such are the areas bounded, in part, by certain curves and their asymptotes. An area may also exist having for its partial limits straight lines, and on one side a line interminable in one direction, or even in both directions, and thus, (19.), specifically infinite; and yet, as it would seem, be finite in surface. Such an area will exist, if the arrangement of its portions be that represented in the figure; each parallelogram having its sides in one direction equal, each to each, to those of any other which are situated in the same direction; but each having its sides, respectively, in the other direction, but one half of the length of those which immediately precede them, in the series. Then if Q be the area of the first parallelogram, or that represented as lowest in the figure, the sum of the "infinite series" or

Fig. 2.



$$S = Q + \tfrac{1}{2}Q + \tfrac{1}{4}Q + \&c. \ldots\ldots = 2Q;$$

the line OY being supposed to be interminable in the direction of

Y. If a similar construction should exist downward, or in the opposite direction, the sum of the areas of both would still be *finite;* it being equivalent to 4Q; but the limit of the surface along OY would be a straight line, (19.), *specifically infinite.* This last must be true, since S would still differ from 2Q, (being an infinitesimal less than it,) if OY produced were only, (19.), relatively infinite: it will be equivalent to 2Q only in case the border or limit OY really have no termination in the direction of Y.*

Comparison and Contrast of a Finite Quantity with the Infinite of its own Species. Relative Zero.

(22.) The distinctions of the various infinites having now been exhibited, we may be the better prepared for the comparison of a finite quantity with an infinite of its own species.

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* If a curve be drawn as in the figure, this curve will be the ordinary hyperbola, and OY its asymptote. Now the *Integral Calculus* will indicate that the area bordered by OP, OY, and the curve is *not finite* when the two latter are interminable in the directions in which the approach of the one to other takes place. Yet this area is less than that of the other surface already described; a portion of that other surface being left out by the construction of the curve: i. e., the area bordered by the curve is less than 2Q; *or it must be finite.* Here, then, is *a paradox.* May it not be true that in this case a concealed term exists in *the constant* which must be introduced, in the integration; especially since the equation applicable to this case, if integrated according to the rule for the integration of differential quantities containing a power of the variable; will exhibit infinity in the result: it being in fact the excepted case; which however may be made to exhibit a finite result, when integrated by the aid of logarithms.

The equation of the hyperbola, the asymptotes being the axes, is

$$xy = \frac{A^2 + B^2}{4} = q. \quad \text{Hence,}$$

$$x = \frac{q}{y}, \text{ and } dx = \frac{-q dy}{y^2},$$

$$\therefore y dx = \frac{-q dy}{y} = -q y^{-1} dy;$$

which is the excepted case.

M. L'Abbé Moigno (*Leçons de Calcul Différentiel et de Calcul Intégral.—Calcul Intégral*, 1re *Partie*, 16.) disposes of the excepted case, in the general, thus: Le second membre de la formule,

$$\int x^m dx = \frac{x^{m+1}}{m+1} + C$$

semble devenir infini pour $m = -1$; mais comme on peut l'écrire sous la forme

$$\int x^m dx = \frac{x^{m+1} - a^{m+1}}{m+1} + C;$$

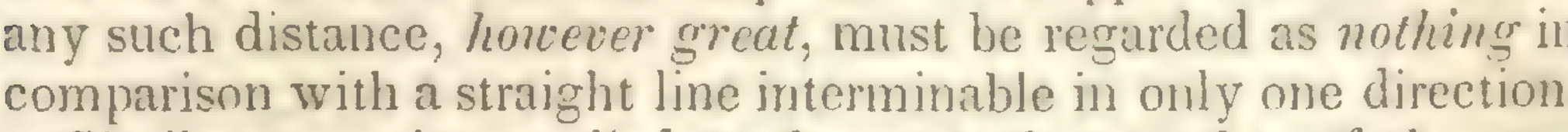
il devient réellement indéterminé; on obtient sa veritable valeur en prenant le rapport $x^{m+1} \log. x - a^{m+1} \log. a$, des dérivées du numérateur et du dénominateur, et y faisant $m = -1$, ce qui donne

$$\int x^{m-1} dx = \int \frac{dx}{x} = \log. x - \log. a + C = \log. x + C,$$

comme on le sait *à priori.*

If a point (P) be assumed in a straight line, (19.), specifically

Fig. 3.

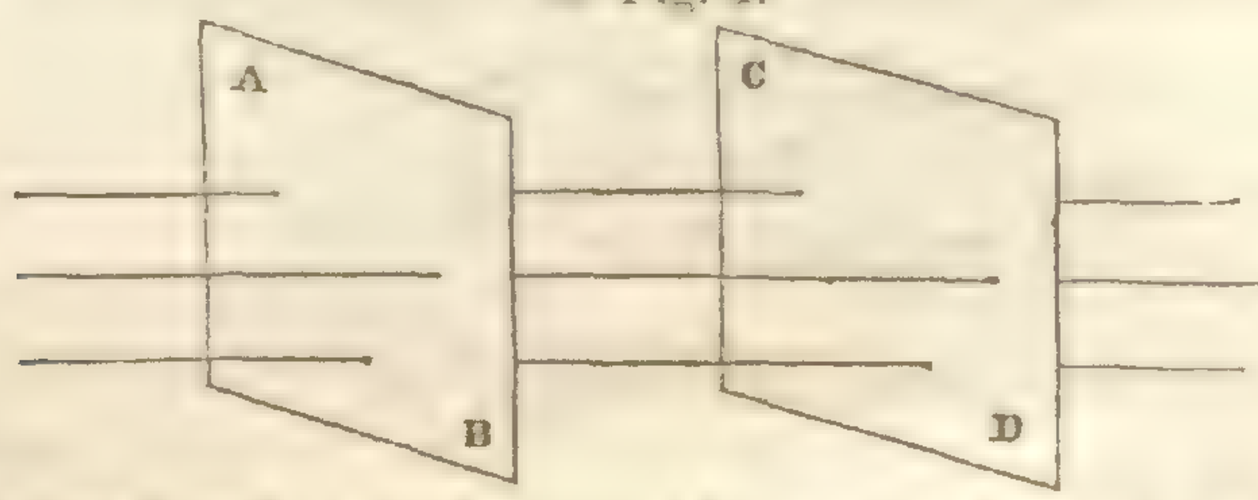


infinite, the line in either direction from that point will be interminable; and the two portions (if they may so be called), one on each side of the point, may be regarded as being, *in effect*, equal. If, again, another point (P′) be assumed in the same line, however remote from the former, the two portions, one on each side of it, may again be regarded as being, in effect, equal; though the whole intervening distance (PP′) will have been added to one of the portions into which the line was divided at the first point (P) and subtracted from the other portion. It appears therefore that any such distance, *however great*, must be regarded as *nothing* in comparison with a straight line interminable in only one direction.

Similar reasoning applied to the case of any other of the specifically infinite quantities described in (19.); (or rather to what in like manner may be regarded as being in effect their halves,) would lead to a similar conclusion with respect to them.

If moreover a plane without border be extended any where in space, all that region of absolute space on the one side of the plane must be regarded as being, *in effect*, the half of all space, and all that region on the other side of the plane, as being, *in effect*, the other half of the same. But the like will be true of the regions found, the one on one side, and the other, on the other side of a plane of the same description, parallel, it may be, to the former, but at any distance from it, however remote; the one

Fig. 4.



being without border and coinciding, in direction in space, with AB; the other alike without border, but coinciding, in direction in space, with CD. But if the dividing or separating limit be at one of these planes, instead of the other, all the intervening space will, as it were, have been added to the one half of all space, and taken from the other. Yet the two regions which are separated by the second plane of which CD is a part, are still to be regarded as being, *in effect*, equal, or each as still, *in effect*, the half of all space.* Hence, all the intervening space separated from the

* In this as in other instances it will be observed, that the truth arrived at, in so far as the so-called halves are concerned, admits of being otherwise illustrated. When a straight line such as PP′ in the figure at the commencement of this article (22.) is finite, the middle is at an equal distance from each end.

But when the line is interminable in both directions, there is no extremity in either direction to measure from, and thus determine the middle. The middle

rest by two planes without border, must be regarded as *nothing* in comparison with the so-called half of all space; though in the space so separated there would be room for all the visible creation, could its form be adapted to the dimensions of that space in those respects in which the dimensions are finite: or the two planes might themselves be supposed to be situated outside of all that we can discover by the best optical aid; and the conclusion still be the same; viz., that the whole space separated by them must be regarded as nothing in comparison with all space; which is itself absolutely infinite.

In the space thus separated, might also exist all the specifically infinite quantities described in (19.)

As the point assumed in the interminable line, *in effect*, divides that line into two halves; and the plane without border in like manner divides all space, so (19.) the instantaneous present divides the Eternity Past from the Eternity Future. It does so (in so far as can be discerned) in all worlds at once; as the same plane in the figure cuts all the three straight lines which penetrate it, and which are to be regarded as interminable in both directions from the dividing plane. The present thus divides those two Eternities now. So, also, it was, in so far as can be discerned, after the first moment of the existence of the first created being or thing, and thus it shall be, after the present system of things, like a worn out "garment," is, as it were, "folded up" and laid aside.

Through the limit thus ever present the current of time passes, in a metaphorical sense; and, moment by moment, the Eternity Future is transferred to the Eternity Past. [We seem to recognize this even in our ordinary language. Thus we say, when to-morrow comes (viz., to us) and not when we come into to-morrow.] As, moreover, in the case of the analogous quantities in space, so, in this case, the transfer, whether of a single day, or of countless ages, from the one Eternity to the other, will be found to leave each of those Eternities *in effect* the half of, (19.), the absolute infinite of duration. Hence in manner as before, all the

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being thus actually indeterminate, may exist, in so far as it exists at all, any where in this line.

The like may be said of all space, which has no borders. Or—with reference to its boundlessness on all sides—that its centre is any where.

A line interminable in one direction may, as already intimated, be regarded as the half of the line interminable in both directions;—but it does not seem to be possible to obtain in the same form any quantity which could be called the one-third, or the one fourth, &c., of the whole. Yet if an interminable curve be supposed to exist of such a form that it might throughout meet the interminable straight line, and, any and every where along it, be found finite portions of the curve, each equivalent to $1\frac{1}{3}$ or $1\frac{1}{4}$, &c. times the corresponding fraction of the straight line, a fraction such as $\frac{1}{3}$ or $\frac{1}{4}$ of the interminable straight line would seem to exist combined with the whole and all expressed together by the interminable curve. It would *seem* to be so; but any such conclusion should be received with caution.

intervening portion of duration thus transferred must be regarded as *nothing* in comparison with either Eternity.

We may thus in some very humble measure learn how it is, that, in the view of the INFINITE MIND, "a thousand years" should be "as one day, and one day as a thousand years."

(23.) A finite quantity in comparison with others of the same species, which are in some respect boundless, has, (22.), been found to be as nothing. We shall therefore designate it in this comparison as *a relative zero;* it being *zero by comparison*, in a more *intense* sense, than the quantities described in (19.) were *relatively infinite*, in *comparison* with others beneath them; and also a more *intense* sense than the same quantities were *infinitesimal*, in *comparison* with those above them.

Character of the Symbols $\frac{1}{0}$ *and* $\frac{0}{0}$.

(24.) If the straight line described in (22.), as interminable in one direction, be assumed as a measuring unit, then any finite straight line being, (23.), a *relative zero*, we shall have for the symbol of the ratio of the greater of these quantities to the less $\frac{1}{0}$; and for that of the less to the greater, $\frac{0}{1}$.*

Since, moreover, the finite straight line is a relative zero, (the line interminable in one direction being the standard); if p denote the length of one finite straight line, and q that of another, we shall have in manner as before,

p represented by or $= \frac{0}{1}$; and q represented by or $= \frac{0}{1}$; whence,

$$\frac{p}{q} = \frac{0}{0}.$$

Or more directly still; p being *relatively* represented by *zero*, and q by the same,

$$\frac{p}{q} = \frac{0}{0};$$

as before.

From this equation, however, neither p nor q can be determined; nor even the *actual ratio*, of the one to the other.

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* The line interminable in one direction is, moreover, either the secant of the tangent of 90°; or, when taken negatively, it is either the secant or the tangent of 270°; and radius of the circle being 1, we have tan. $90° = \frac{\text{sin. } 90°}{\text{cos. } 90°} = \frac{1}{0}$; and sec. $90° = \frac{1}{\text{cos. } 90°} = \frac{1}{0}$; results agreeing with the preceding determinations, when the greater line was regarded as *the unit*, and the less became *a relative zero*.

The indeterminate character of the symbol $\frac{0}{0}$ *is thus established by primary considerations.*

[In the case now described the symbol or form $\frac{0}{0}$ presented itself, because the terms were *zero* in *comparison* with a standard unlimited in at least one respect. In the instance of a fraction such as that represented in the equation,

$$\frac{Fx}{fx} = \frac{P(x-a)^m}{Q(x-a)^n}$$

which, when $x=a$, becomes,

$$\frac{Fx}{fx} = \frac{P\times 0}{Q\times 0} = \frac{0}{0};$$

the form or symbol $\frac{0}{0}$ appears, because the particular value of x reduces each of the multipliers, $(x-a)^m$ and $(x-a)^n$, to *zero*. Hence *no product* can, in effect, result, whatever may be the value of the multiplicand; i. e., (14.), *nothing* will be found in the place of the numerator as well as that of the denominator: or the value of the fraction, in its form of $\frac{0}{0}$, becomes indeterminate, not as in the former case, because of the character of the standard of reference, but because of *the actual disappearance* of every thing from both terms of the fraction, which under other circumstances, could render them *definite*.]

Another Application of Preceding Principles.

(25.) [The relations of things being, as already maintained in (4.), *constituted relations*;—and they also being constituted in some respects alike, as appears from the comparisons between those of space and time in (22.)—we may even reverentially proceed a step farther, and conclude, that, as any finite (or even in some respects boundless) space is *worthless*, or to be regarded as *good for nothing*, *in comparison* with the *absolute infinite of space*; and as, again, any finite portion of duration is also *a relative zero*, in comparison with *the absolute infinite of duration*; so, also, must the highest created intelligence and lowest among men be *alike worthless* or regarded *as nothing* in comparison with the ALONE INFINITE ONE: or man, placed as it would seem lowest in scale of such intelligences, must be represented, in comparison, as being as it were "less than nothing." This truth has important moral bearings; but this presentation might be regarded as out of place in a mathematical dissertation.]

Wherein Necessary Truth is to be found, and the Final Hypothesis.

(26.) The consideration of the two great relations of things, duration and space, has often prompted the question whether, if the visible universe were annihilated, space would remain?

On the one hand—since the limits of things actual are, (8.), no part of those things; but their surfaces, as connected with the things themselves, bound them and are removed whenever and wherever those things are transferred; yet cannot be removed *from* the things, and thus placed by themselves—it would seem, from all this, that what is less a relation of things, would, if those things were gone, not exist *by itself;* or *no longer be.*

On the other hand, surface, &c., are *dependent* relations of things—as must appear from what has just been stated—while space is independent of them, in so far, that when the thing is removed the space, (15.), which it occupied, is forsaken or left behind; and may be again occupied by something else. Hence, it would seem that, if all such things were gone, space would *still be.*

Certain it is, moreover, that, in so far as we can discern, if the visible creation were annihilated, there would be room for another. But does this conclusion amount to anything more than the assertion, That, under the new system of things, space would again exist as a relation of them; as it does now? If so, then this cannot determine what would be, if there were *no* such things. It appears then that such a state (or rather absence) of things is so far without the pale of our experience, that we can form no adequate idea of it; and must therefore leave the question of the existence or non-existence of space, in the absence of such a creation as we now have, without an answer.

But whatever the reply to that question ought to be—space exists not, nor can it exist independent of the GREAT FIRST CAUSE, who formed all things, and "by whom they also *consist;*" with whose existence, moreover, the absolute infinite of duration, (19.), is interwoven.*

Could space, indeed, exist independent of HIM, or does it so exist, then it exists not of "his good pleasure"—then was it not *created*—then must it be *self-existent*—but then must it, also, be found *in* HIM; which contradicts the hypothesis: and that hypothesis must therefore fail.

We know therefore of no space which is not pervaded by his presence, as we are certain that there is no duration which "He inhabiteth" not.

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* If it were imagined that *Duration* might exist, *though* THE FIRST CAUSE *were not*, —the reply must be that the hypothesis of its non-existence is itself the greatest possible absurdity—to say nothing more.

The relations of things, as we have them, will remain the same while HE is pleased to continue the present constitution and arrangement of things. *Unalterable*, then, these relations must be; but, being the opposing of "his good pleasure," they cannot be *necessary;* for then, as already shown, they must be regarded as interwoven with his own existence: i. e., existing as the necessary relations of his being, which is itself necessary.*

To suppose these relations, or even the most abstract truths respecting them, to be *necessary*, would be to make them not the *relations* of things or beings, (or ultimately of the ONE SELF-EXISTENT BEING,) but *existences or things themselves*. If they existed *necessarily* and, of course, previous to a creation, *where* and *how* did they exist; unless in the discernment and prescience of the DIVINE MIND? The admission that they could exist *only there*, will itself be the full admission of all that has been asserted. *Truth*, *beauty* and *goodness*, then, are but the outflowings of his adorable perfection—of his infinite excellence; and their "*eternal*" laws are but transcripts of the same. Because of that perfection and excellence HE is gloriously above all control; and the origin and rule of all that is true and right, exists neither *above* nor *beside* HIM, but is found *in* HIM.

In his self-existence, therefore, as it "was, and is, and is to come," is to be found THE *one*, *the absolutely necessary truth:* all others are contingent, just so far as HE has made them so. Herein, is to be found, moreover, *the great*, *the final hypothesis*, upon which rests *the structure of the universe;* and which, too, undergirds and sustains that universe, in *all its relations*.

ART. XXIX.—*Results additional to those offered by Dr. Locke from his Three Experiments, "On Single and Double Vision produced by viewing objects with both eyes;"* by S. PEARL LATHROP, M.D.

FEELING an interest in the various branches of optics, I read with much pleasure, the article "On Single and Double Vision, &c.," by Dr. John Locke, in the January number of this Journal. Having acquired, as he says of himself, the power of voluntary convergence of the optical axes to an *extreme* degree without the aid of viewing near objects, I have verified the several experiments mentioned by him.

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*The seeming contradictions, *if any*, which this might involve in the case of truths called axiomatic, must be regarded as but *seemings;* and as arising from our inadequate comprehension of the relations in question, and inexplicable for reasons which may, perhaps, be similar to that which prevents us from discerning *how*, in eternity past, time e'er began; though we cannot escape from the belief of *the fact*, that it *somehow* occurred.

In performing the second and third experiments, I found, in *addition* to what is mentioned by Dr. Locke, by a still greater degree of convergence of the optical axes, other results of an interesting character. The second experiment is the following: Two candles of equal size and height were placed side by side on a table, and, by converging the axes of the eyes, four images were produced. As the convergence progressed, each pair of images receded gradually from the original place of the single image until the two contiguous ones—the second and third, approached, and finally coalesced into one, when three images only were in view. This he illustrates in the following manner, using letters, in the place of which I have substituted squares, representing the pieces of paper which I employed in performing the experiments. These were laid upon a dark colored spread.

Thus: No. 1. 1 2 □ □—Natural single vision. No. 2. 1 2 3 4 □ □ □ □

—View with axes slightly converged. No. 3. 1 2,3 4 □ □ □—View with greater convergence of the optical axes and the two intermediate images coalesced into one. By a still greater convergence, I have found that the second and third images—now coalesced—can be made to pass by each other, when four images

will again be seen, as follows; No. 4. 1 3 2 4 □ □ □ □. As the convergence commences, these intermediate images are seen to recede from the place of the original images, when four images are seen, as in No. 2; then to approach one another and coalesce, when three images only appear, as in No. 3; then to pass by each other, when four images are again seen. By a yet greater convergence I am able to cause the image marked 3, in No. 4, to lap upon the image marked 1; and the image marked 2, to lap

upon the image marked 4, as follows: 1 3 2 4 □□ □□. From which I infer, that by a still greater convergence, these images can be made not only to coalesce—when two images only would be seen—but to pass by each other, when four images would again

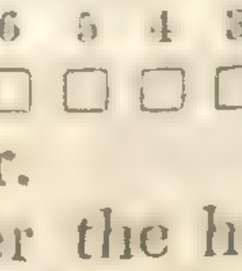
appear in the following position: 3 1 4 2 □ □ □ □, and so on, till the images marked 1 and 4 coalesced and passed by each other, and even till all the four images had changed their relative position

and assumed the following 4 3 2 1 □ □ □ □,—that is, the reverse of the order in No. 2.

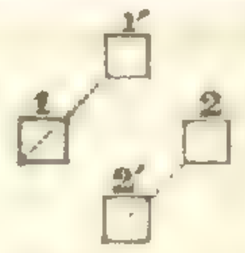
I tried the experiment with three, and with four pieces of paper, and found the same principle to prevail as with two, the only modifications being those which would arise from the greater number of images. With five pieces of paper I was unable to preserve the images distinct, or to bring them all in view, but

very easily discovered that the same law was followed in the order of their appearance. The appearances from three pieces of paper were the following—commencing with "natural single vision," and numbered in the order of the degree of convergence. The images that are doubled are placed nearer each other than the others; No. 1. □ □ □—No. 2. □ □ □ □—No. 3. □ □ □ □ □, or □ □ □ □ □ according as the *attention*, or the eye, is turned more particularly to the right or left. No. 4. 1 2 3 4 5 6 □ □ □ □ □ □—No. 5. 1 2 3,4 5 6 □ □ □ □ □—where the images 3 and 4, separate in No. 4, are here made to coalesce. No. 6. 1 2 3,4 5,6 □ □ □ □, or 1,2 3,4 5 6 □ □ □ □, according as the attention is given to the right or left. No. 7. 1,2 3,4 5,6 □ □ □—where we have three images again. No. 8. 1,2 4 3 5,6 □ □ □ □—where the images 3 and 4 have been made to pass each other while the other remains united. No. 9. 1,2 4 3 6 5 □ □ □ □ □, or 2 1 4 3 5,6 □ □ □ □ □—according as the attention is given to the right or left. No. 10. 2 1 4 3 6 5 □ □ □ □ □ □—where each of the images of the several pairs have been made to pass its fellow, and six images again appear. I am nearly able to lap the images marked 1 and 4, and those marked 3 and 6, as in the case with two pieces of paper, as follows: No. 11. 2 1, 4 3, 6 5 □ □ □ □. By continuing to increase the degree of convergence these images can be made to coalesce, so that there will again be only three images, thus: 2, 4 1, 6 3, 5 □ □ □, and even to assume a position reverse to that in No. 4, thus: 6 5 4 3 2 1 □ □ □ □ □ □, as was said in the instance of two pieces of paper.

Under the head of "some of the phenomena of the illusive image," Dr. Locke observes,—"as the head is inclined to the right or left, the superimposed pictures slide out from each other, the one ascending and the other descending to the extent of the inclination." I found, when using two pieces, with a convergence of the optical axes sufficient to produce three images, that if the head be then inclined to the right shoulder at an angle of 45°, there would then appear four images in the following position:

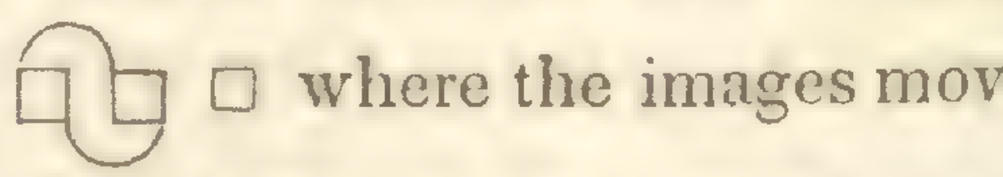


By permitting the convergence to diminish gradually, the images marked 1′ and 2′ would be seen to move along the dotted lines and finally coalesce with the images 1 and

2 at the moment there was no convergence. On the other hand, if the head be inclined to the left, at the same angle, the images would assume a similar position but would coalesce differently, as the convergence was diminished, as follows: 

. If the head, in either of these cases, be made to lie parallel to the shoulders, or so that the eyes will be vertical, the images will assume the following position:

, where the images marked 1 and 4 are the illusive images when the head is inclined to the right, and those marked 2 and 3 the illusive when the head is inclined to the left. The position of these images is found to be the same as will be assumed, when the convergence of the optical axes is brought to bear upon two pieces of paper, placed the one above the other, in the following manner:
.

Instead of the intermediate images in No. 2, in the experiment with two pieces of paper, being made to coalesce with one another, as seen in No. 3 of the same experiment, they can be made, while passing each other, to *turn out* to the right or left, as follows:
, or 
where the images move in the direction of the lines with which they are connected.

In performing the third experiment of Dr. Locke, "of converging the optical axes upon two contiguous figures on the wall paper," and thereby obtain an image in front of the wall—called by him "illusive image"—I was not so successful. An "illusive image" is indeed seen, but it possesses so *much* of that character as not to permit of my treating of it. I find no difficulty, however, in superimposing pictures, or pieces of paper of different sizes.

The principle involved in all of these results seems to be embraced in the 5th inference of the first experiment of Dr. Locke, of seeing two images when the convergence of the optical axes is brought to bear upon one object, viz., "*that certain parts of the retina of one eye* CORRESPOND *to certain specific parts of the retina of the other eye in such a manner that when identical pictures fall on those corresponding parts single vision is the result.* Those corresponding parts lie inward in one eye and outward in the other, viz.: both to the right or both to the left. From each of those corresponding parts of the retina, it is probable that the fibres of the optic nerve proceed, and severally unite at the point of anatomical communication where the optic nerves cross, before entering the brain; hence the single impression or single image."

It appears that the eyes of an individual are not a *pair* in the sense of the word as applied to gloves—the one designed for the right and the other for the left hand, but two *alike*, performing the office of vision just as well if their places should be changed. This offers a perfectly satisfactory answer to the question—why we do not see objects double with two eyes.

Art. XXX.—*Observations on American Species of the Genus Potamogeton, L.;* by Edward Tuckerman, A.M.

(Continued from vol. vi, p. 224.)

The following notes, as well as those already printed in this Journal, have been in every instance derived from examinations of living plants, enlarged by subsequent comparison of dried specimens. The terminology is that of Chamisso's Monography; and beside this, reference has been made constantly to the revision of the Swedish Potamogetons by Fries, in his *Novitiæ*, and to Koch's *Synopsis* of the German Flora. I may be permitted to add that I owe to Professor Nolte, of the University of Kiel, who has pursued for many years the study of these plants, which he has illustrated in his Novitiæ, and elsewhere,—and who first directed my attention to them, a large and invaluable set of the species of Schleswig and Holstein.

Potamogeton natans, (L.): caule simplici tereti; foliis omnibus longe petiolatis, natantibus coriaceis subcoriaceisve ovato-ellipticis basi sæpius cordatis apice obtusiusculis submucronatis oblongis ellipticisve multinervibus, petiolis concaviusculo-convexis; petiolis submersis inferioribus aphyllis acuminatis; stipulis elongatis lineari-linguiformibus acutis; pedunculis crassis subæqualibus foliis brevioribus; spicis cylindricis densifloris; fructibus remotibus oblique obovatiusculis, stylo brevi faciali apiculatis, dorso arcuato obtusiuscule carinatis, lateribus convexis in faciem acutiusculam declivibus. *P. natans, L. Succ.* 145, *e Fr. Chamiss. in Linnæa*, 2, 217, *t. vi, f.* 20. *Fr. Novit. Fl. Suec., p.* 28. *Koch. Syn., p.* 672. *A. Gray! Man. Bot., p.* 455, *a. Wood Bot., p.* 524, *e descr.*

Hab. In stagnant and in flowing water; common in New England. The description was taken from specimens growing in stagnant pools near Lake Champlain, at Burlington, Vt., which agree generally with specimens from other parts of New England, and from Western New York, (*Dr. Sartwell!*) Fl. June and July. Fr. August and September. Stems simple, terete, many arising from the creeping root. Leaves all on long footstalks; the lowest bladeless and acuminate; the others ascending toward

the surface of the water and floating, from membranaceous at length more or less chartaceous-coriaceous, not attenuate at base, broad- or ovate-elliptical, with very commonly a cordate base and an obtuse and more or less distinctly mucronate tip, many-nerved, often about $2\frac{1}{2}$ inches long by nearly $1\frac{3}{4}$ wide; the footstalks slightly concave above. Stipules elongated, acute. Peduncles nearly equal, shorter than the leaves. Nutlets rather large, obliquely a little obovate, the arched back obtusely carinate, (acute when dry,) the sides at length convex and sloping to the acutish face which is apiculate with the short style. Exocarp thick, thickened above. Putamen very thick, woody. Seed uncinate, or somewhat 'curviusculo-uncinate,' (Cham.) The exocarp being removed, the nutlets appear obscurely tricarinate from a sunken line on each side of the acutely-carinate back, and the sides are slightly impressed in the middle. As compared with the fruit of *P. natans* that of *P. amplifolius* is lunate, and the exocarp being removed still mucronate with the style, the sides are conspicuously impressed at the middle, and the back is rounded-carinate.

Potamogeton fluitans, (Roth): caule simplici tereti; foliis omnibus in petiolum attenuatis, submersis membranaceis plus minus petiolisque elongatis, multinervibus; natantibus coriaceis late lanceolatis ovalibusve, petiolis rotundatis lamina plerumque haud longioribus; stipulis elongato-linguiformibus bicarinatis acutis; pedunculis incrassatis; spicis cylindraceis densifloris. *Roth. Germ. e Nolt.! Novit. Holsat., p.* 16. *Chamiss. l. c., p.* 219–221. *Fr. Novit., p.* 29. *Koch. Syn., p.* 673. *P. natans, β. Chamiss. Adn., p.* 4, *& Auct. pl. A. Gr. Man. Bot., p.* 455.

Hab. Erie Canal near Seneca Lake, and in stagnant brooks emptying into the same lake, New York. Stem simple, terete. Leaves all attenuate into the roundish (above scarcely flattened) foot stalks, and acute both ways; the submersed ones lanceolate, more or less elongated, membranaceous, many-nerved closely netted-veined, on rather elongated footstalks; the floating ones coriaceous, broad-lanceolate or oval, acute, many-nerved and about 6 nerves prominent beneath, very closely netted-veined, from about $2\frac{1}{2}$ to $4\frac{1}{2}$ inches long, by 1 to $1\frac{1}{2}$ in. wide, on footstalks mostly shorter and never longer than the blade. Stipules much elongated, strongly 2-ribbed, acute. Peduncles thickened, shorter than the leaves. 'Nutlets compressed, acutely carinate.' My specimens are without fruit, but agree in every other respect with those of Prof. Nolte, from Holstein, which are cited by Chamisso, Fries, and Koch. The species is considered distinct by these authors, and without regarding the fruit, the American plants appear to differ from *P. natans* equally with the European, in the attenuate base of their leaves, in the submersed leaves being always present, in their more rounded petioles, and their bicarinate stipules.

Potamogeton amplifolius, Tuckerm. This species, indicated in the previous number of this Journal already referred to, occurs very abundantly in Lake George, and in Seneca Lake, New York, in a wholly submersed state, growing in deep water, when its length, its large leaves, and its finally much elongated peduncles make it perhaps more striking than any other of our Potamogetons. Between this, which is probably to be considered the more perfect, if not the typical state, and that which I have found most common in New England, and described as above, in which the habit of the plant is altered by the emergence of its apex, and the consequent production of floating coriaceous leaves, there is another, in some respects intermediate form, proper apparently to shallow pools, which demands separate notice. The stem in this last is much abbreviated, and the approximated leaves, either all submembranaceous, or the upper ones coriaceous, are shorter, firmer, and more oval. I gathered my specimens near the Niagara river, on the Canada side, and a similar plant, sent from Kentucky by *Dr. Short*, is in Prof. Torrey's herbarium. It is probable that the three states thus indicated,—that peculiar to deep water, and wholly submersed (*forma homophylla*, Fries.), that with floating leaves differing from the submersed ones, in shallower water (*forma heterophylla*, Fr.), and the third occurring where there is least water, and passing into abnormal forms (*forma amphibia*, Fr.) are all the prominent ones of the present, as of many other species. The differences between plants of still deep water (*status lacustris*, Fr.) and those of flowing water (*status fluviatilis*, Fr.) though often striking as respects the leaves, are much more easily appreciated than the above. The fruit of this species is more or less distinctly lunate, the sides somewhat flattened, and the exocarp being removed the style is persistent, and the back rounded-carinate; a sunken line on each side more or less defining the subobsolete, obtuse lateral keels. The *heterophylline* state extends westward to Fort Gratiot, (Dr. Pitcher, *Herb. Torr.!*)

Potamogeton rufescens, (Schrad.): caule simplici tereti; foliis submersis membranaceis, superioribus nunc subpetiolatis reliquis sessilibus, validiusculis anguste lanceolatis basi apiceque attenuatis acutiusculis multinervibus nervis 3–5 conspicuis; natantibus subcoriaceis planis nervis circ. 7 subtus prominulis plus minus obovato-lanceolatis apice acutiusculis, in petiolum compressum concavo-convexum lamina breviorem attenuatis; stipulis hyalinis elongatis levissime nervosis acutis; pedunculis subaequalibus plano-convexis elongatis; spicis cylindricis rufescentibus; fructibus recentibus lenticulari-compressis obovatis, stylo subapicali mucronatis, dorso acutiuscule subalato-carinato, lateribus convexis utrinque declivibus, facie acutiuscula. *P. rufescens, Schrad. in Chamiss. Adn., p.* 5, e Cham. *Chamiss. in Linnæa,*

2, *p.* 210. *Fries. Novit., p.* 30. *Koch. Syn., p.* 674. *Kth. Enum.*, 3, 129. *A. Gr. Man. Bot., p.* 455. *P. oppositifolius, DC.* e Cham. *Nolt.! Nov. Holsat., p.* 17.

Hab. Stagnant and flowing waters. In the two streams at the foot of Lake George, New York. Also in the rapids of the Niagara near Bath Island, and according to Chamisso in the river Mistassin. Stem terete, (often, as well as the peduncles and petioles somewhat muricate with regular, prickle-like excrescences,) mostly simple, but in luxuriant states often branching above, the whole plant and especially the upper portion becoming more or less purplish-rufescent when dry, 1½ to 3 feet long. Submersed leaves membranaceous, slightly rigid, rather narrowly lanceolate, tapering to the base, and more or less so above to the acutish tip; the upper ones often petiolate, the rest sessile; many-nerved, from 3 to 5 of the nerves more conspicuous; rather closely netted-veined; 2–4 inches long by 3–7 lines wide. Floating leaves (often wanting) subcoriaceous, flat, oblong- or obovate-lanceolate, acute above, with about 7 prominent nerves on the under side, 2–4 inches long by 3–9 lines wide, tapering at the base to the compressed, concave-convex petioles, which are shorter than the blade. Stipules rather long, delicate, acute (finely ribbed when dry.) Peduncles scarcely thickened in the smaller plants from Lake George, but evidently so in those from the Niagara, elongated, plano-convex, 2–5 inches long. Spikes cylindrical, many- but not continuously nor densely-flowered, 1–2 inches long. Nutlets lenticular-compressed, mucronate with the short style, the sides convex at the middle and sloping each way, the back rather obtusely subalate-carinate, (acute when dry, and the lateral keels often evident.) the face commonly also carinate, and acutish. Exocarp thick, produced at the back, and forming the wing. Putamen rather thick and hard. Seed convolute-uncinate. The exocarp being removed, the back appears acutish, with a sunken line on each side. The American plants above cited agree with the European in every important character. The Niagara specimens are often branched above, but this is doubtless owing to their luxuriant growth, to which I also attribute the thickening of their peduncles. The peculiar murication of the stem, &c., also occurring in the Niagara specimens, I have observed in another species not yet described in this place.

Potamogeton lonchites, Tuckerm. in Sill. Journ., l. c. The *homophylline* or wholly submersed form is common in company with the *heterophylline*, and with that, is abundant in the Connecticut, in Massachusetts, where I have gathered specimens with leaves a foot long. These forms, always characterized by their slender habit, long and narrow, very loosely veined, membranaceous submersed leaves, rather rounded petioles, and smallish fruit, appear to extend westward to the Kentucky river, (Dr. Short. *Herb.*

Torr. !) I gathered in the Niagara rapids, near Bath island, and have since received from Penn Yan, New York, (*Dr. Sartwell,*) a remarkable state of this species probably to be referred to the *amphibious* form of Fries. In this the stem is simple (compare Fries's observations, *Novit.*, p. 39, on an analogous state of *P. gramineus* '*primo obtutu cum P. oblongo conjungenda*'), and the broad, oblong, or oval leaves are either all coriaceous and floating, or only the lowest submembranaceous; the length of the flattened petioles being often almost the only index to the real affinity of the plant, the whole habit of which accords, often strikingly, with that of *P. fluitans;* but its strongly marked fruit at once refers it to the present species. The published description of the fruit of this species was from immature nutlets. The following is taken from perfectly ripe ones observed in the Niagara plants, in those of the Connecticut above mentioned, and (in the dry state) in the admirable specimens of *Dr. Sartwell.* Fr. recentes oblique obovati lunati, compressiusculi, subtricarinati, stylo apicali apiculati, dorso arcuato acute præcipue superne subalato-carinato sinuato-dentati, carinis lateralibus subobsoletis, facie recta obtusa. The lateral keels are conspicuous when dry. Exocarp thin. Putamen thick, and thickened above. Seed *uncinate*, a little curved. The exocarp being removed, the back appears acutely carinate, and a little alate, especially above; with a sunken line one each side defining the rather obscure, obtuse, lateral keels; the sides a little impressed at the middle. At the conclusion of the Monography of Chamisso a large number of *Potamogetons*, exotic as respects Europe, of which the specimens were insufficient to permit of their satisfactory determination, are thrown together as provisional varieties of *P. fluitans;*—the learned author, leaving it, as he says, to others, to distinguish and designate these plants, so far as might turn out to be necessary, as species. Two of these (pp. 226, 227) have been already referred, in the previous number of this Journal, already cited, to *P. Claytonii;* and the only remaining North American *Potamogeton* noticed, (*P. fluitans*, c. *Americani*, *Americanus*, thus provisionally designated, p. 226,) is most probably an *amphibious* state, like one above described from Niagara, of *P. lonchites;* and if so, as the species just named is typically, judging from its most perfect conditions, a branched *Potamogeton*, of a distinct tribe from *P. fluitans*, there can be no doubt of the necessity of separating Chamisso's plant from the latter. It is however so near to the *P. nodosus* of Poiret, Enc. Suppl. iv, p. 535 (the *P. fluitans*, c. *canariensis*, *nodosus*, Chamiss. l. c., p. 222), as the German author himself remarks, that I cannot but consider it possible that the several American plants, brought together, in these papers, under the name of *P. lonchites*, together with Chamisso's specimens above quoted, may finally prove to be identical with the older

species of the Canary Islands. What relation to this the '*P. occidentalis*, Sieber,' of the West Indies, (*P. fluitans*, d. *occidentalis Antillanus*, Chamiss. l. c., p. 224,) may have, must be left to future investigation.

Potamogeton gramineus, (L.): caule gracili tereti ramosissimo, ramis ramosis dense foliosis; foliis submersis membranaceis lineari-lanceolatis breviuscule acuminatis basi attenuatis nervis 3–6 obscuris, caulinis latioribus, superioribus petiolatis, rameis minoribus reliquisque sessilibus, petiolis supra planis; natantibus minusculis chartaceo-coriaceis submembranaceisve lanceolatis ellipticis ovato-ellipticis ovatisve, petiolis longiusculis compressiusculis plano-convexis; stipulis gracilibus lineari-linguiformibus margine scariosis acutiusculis; pedunculis leviter incrassatis spicis cylindraceis longioribus; fructibus recentibus minusculis oblique subrotundo-obovatis lunatis compressiusculis, stylo brevi subapicali apiculatis, tricarinatis, carinis superne productis acutiusculis, lateribus convexis, facie superne producta obtusa. *P. gramineus, L. Suec.* 2. *n.* 151, *e Fr. Novit*, *p.* 35. *Wahl. Lapp.*, *p.* 52. *Koch. Syn.*, *p.* 674. *Kth. Enum.* 3, *p.* 130. *P. heterophyllus, Schreb. Spicil. Fl. Lips.*, *p.* 21, e Chamis. *Nolt.! Novit. Fl. Holsat.*, *p.* 18. *A. Gr. Man. Bot.*, *p.* 455, (excl. *P. Claytonii.*) *P. Proteus γ. heterophyllus, Chamiss. in Linnæa*, 2, *p.* 202, *t. v, f.* 16. *c. f. g. h.*

Hab. Still and flowing waters; very common in the ponds and streams of New England; and the lakes of Western New York; and extending westward to Lake Superior, (*Prof. Agassiz!*) Stem slender, terete, in the forms of shallower water much branched, the branches in these forms being also approximated, and all as well as the stem, often terminated by floating leaves; in those of deep water (as of Lake George, and Seneca Lake, N. Y.) less branched and not at all at the upper extremity, the internodes also much elongated. Submersed branches always ramulose and thickly clothed with leaves, smaller and narrower than those of the stem. Submersed leaves membranaceous, pellucid, linear-lanceolate, a little acuminate above, tapering at the base, obscurely 3–6 nerved, obsoletely netted-veined, those of the stem larger and the upper ones more or less petiolate, 2–3 inches long, 3 by 5 lines wide, the petioles flat above; those of the branches smaller, more linear, ¾ in. to 1½ inches long by 1–3 lines wide. Floating leaves chartaceous, or often submembranaceous (or wanting), always rather delicate, from lanceolate varying to ovate and obovate, but very commonly elliptical or ovate-elliptical, with a more or less obtuse base; those of the deep water forms smaller, and commonly submembranaceous; with about 6–8 inconspicuous, impressed nerves on the under side, on compressed, plano-convex, scarcely elongated petioles Stipules of the branches very small, but those of the stem larger,

rather slender, short, more or less scarious at the margins, acutish. Peduncles a little thickened, rather more than twice as long as the spikes, but elongated in the deep water forms, and occurring 10 inches and more in length. Spikes slender, densely flowered. Nutlets small, somewhat rounded, obliquely obovate, lunate, 3-carinate, the keels a little prominent and acutish above, the sides convex, the face produced above and apiculate with the very short style. Exocarp rather thin. Putamen thickish, but not hard. Seed curved-uncinate. The exocarp being removed, the sides appear rather suddenly hollowed, at the middle, toward the face. Agrees with the European specimens in habit, in the leaves, and the fruit. *P. lonchites* is at once distinguishable from the present species by its large size, and the different habit induced by its nearly simple branches; and its dentate-cristate fruit separates it from every described European species. The leaves of *P. gramineus* often approach a sublinear form, but the proper affinity of the species is with *P. nitens* and *P. lucens*, and not with the Graminifolii, or truly linear-leaved section.

Potamogeton compressus, (L.): caule alato-complanato ramosissimo; foliis omnibus submersis saturate viridibus membranaceis lincaribus versus apicem sensim vix attenuatis apice breviter acuminatis cuspidatis, basi haud attenuatis sessilibus, 3–5-nervibus, infimis brevioribus multinervibus; stipulis linguiformibus pellucidis acuminatis demum laceris; pedunculis compressis spicis cylindricis continuis haud duplo longioribus; fructibus recentibus obovato-oblongis, stylo apicali leviter recurvo-rostratis, dorso latiore acute carinato sinuato-dentato, carinis lateralibus obsoletis, facie obtusa. *P. compressus, L. Suec. n.* 203, *e Fr. Novit., p.* 45. *Torr.! Fl. U. S., p.* 198. *Koch. Syn., p.* 676. *Beck.! Bot., p.* 386. *A. Gr.! Man. Bot., p.* 456. *Wood Bot., p.* 526. *P. zosteræfolius, Schum. Enum. pl. Suel.* e Cham. *Nolt.! Novit. Fl. Holsat., p.* 19. *Chamiss. in Linnæa,* 2, *p.* 182. *t. iv. f.* 10.

Hab. Ponds and slow streams, common in New England, and westward. In the western part of New York it attains to a much larger size than with us, and often not a little resembles Scholera, with which I found it growing. Stem much compressed, and winged, very much and long branched, 1–2½ feet long. Leaves dark green, all submersed and membranaceous, linear, above sensibly a little attenuate toward the abruptly and shortly acuminate and cuspidate tip, at the base not attenuate, sessile; 3–5-nerved; sparsely and obsoletely here and there veined; 3½ to 8 inches long by 1¼ to 2 lines wide; the lowest ones shorter, broad-linear, obtusish and submucronate, many-nerved. Stipules large, delicate, pellucid, green with whitish margins, finely many-nerved and the two lateral nerves prominent, acuminate and at length lacerate. Peduncles compressed, not reflexed in fruit, com-

monly not twice as long as the cylindrical, rather few-flowered spike. Nutlets large, oblong, a little rostrate with the apical, slightly recurved style; the bread back acutely carinate, and sinuate-dentate, with one prominent tooth near the base; the lateral keels obsolete, sides rather convex, and impressed at the middle, (but not so, according to Chamisso, in the entirely mature fruit;) the face obtusely carinate. Exocarp thick. Putamen thickish, not hard. Seed uncinate-convolute. Chamisso does not describe the fruit of *P. compressus* as minutely, in some respects, as in other species, and his figure corresponds less nearly with the nutlets of our plants, than the general features of his description. The dentation of the back is not mentioned in any description that I have seen of the present species, and if, as appears to me nearly certain, the American plants above described are inseparable, specifically, from the European, this character, a conspicuous one in several American species, must be reckoned of secondary importance.

Potamogeton Niagarensis, (Sp. nov.): caule complanato ancipiti rigidiusculo ramoso; foliis omnibus submersis membranaceis firmioribus linearibus versus apicem sensim attenuatis apice acutis mucronulatis, basi attenuatis subpetiolatis, sub-trinervibus; stipulis lato-linearibus membranaceis acutiusculis demum laceris; pedunculis compressis clavatis brevissimis; spicis paucifloris capitatis; fructibus recentibus lenticulari-compressis oblique subrotundo-obovatis stylo apicali mucronatis, dorso deorsum curvato acute lato-alato-carinato, carina supèrne subgibboso-producta, sinuato-dentata, lateribus convexiusculis in faciem subalato-carinatam declivibus.

Hab. Niagara falls, near the brink of the Hog-back, growing plentifully with Udora; and elsewhere in the river. Fr. August—September. Stem much compressed and sharply two-angled, firm, much branched, 1–2 feet long. Leaves all submersed, membranaceous, rather firm, dark green, linear, above sensibly tapering to the suddenly acute and mucronulate tip; at the base much attenuate, subpetiolate; 3–5-nerved, the exterior lateral nerves commonly obscure or obsolete; the space next the midrib on each side more or less evidently reticulate-cellulose; very obsoletely and sparsely veined; 1½–3½ inches long by half a line to rather more than a line wide. Stipules broad-linear, membranaceous, finely nerved, acutish at the tip, which is at length lacerate or even setose; the longest 6–8 lines long. Pedunces not numerous, axillary, erect, very short, compressed, clavate, 2–4 lines long. Spikes few- (8–12) flowered, capitate, subglobose. Nutlets somewhat rounded, lentiform-compressed, the back curved downward below the apparent base, broadly alate-carinate, sinuate-dentate, a little hunched above, the sides convex and sloping to the alate face which is produced-acute at the

middle, the style apical. Exocarp thin, produced at the back and forming the wing, and less so, also, at the face. Putamen thickish. Seed convolute-uncinate. Intermediate in size between *P. compressus* and *P. pusillus* α, major, but differing in its characters from all our described species of this section.

Potamogeton pusillus, (L.): caule subcompresso ramoso; foliis omnibus submersis membranaceis pallide vel demum fuscescenti-viridibus linearibus apicem versus levissime basique brevissime attenuatis sessilibus, basi plus minus conspicue bi-landulosis, 3–5-nervibus, subobsolete venosis; stipulis linguiformibus pellucidis acutiusculis; pedunculis longiusculis subcompressis spicis subinterruptis vel confertis capituliformibus longioribus; fructibus recentibus oblique ellipticis, stylo subapicali brevissime rostratis, subtricarinatis, carina dorsali rotundato-obtusa deorsum curvatiuscula, lateralibus obsoletis. lateribus convexis, facie obtusa. *P. pusillus, L. Suec., n.* 153. *Chamiss. in Linnæa*, 2, *p.* 170, *t. iv, f.* 5. *Fries Novit., p.* 48. *Koch. Syn., p.* 677. *Kth. Enum.*, 3, *p.* 136. (excl. δ.) *Torr.! Fl. N. Y. A. Gr. Man. Bot., p.* 457.

α *major*, (Fries.): caule compresso minus ramoso; foliis latioribus obtusiusculis submucronatis sæpius 5-nervibus venosis; spicis plus minus cylindricis interruptis. *P. pusillus*, α, *Chamis. l. c. Fries l. c. Koch. l. c. Kth. l. c. P. compressus, E. Bot.*, *t.* 418, e. Fr. *Mert. & Koch. Fl. Germ.* 1, *p.* 856, e. Koch, non L.

β. *vulgaris*, (Fries.): caule filiformi e tereti-subcompresso ramosissimo; foliis angustioribus acutiusculis 3-nervibus subavenüis; spicis sæpius abbreviatis floribusque capitatim confertis. *P. pusillus*, γ, *Chamiss. l. c. P. pusillus*, β, *Fries l. c. Koch l. c. Kth. l. c. P. pusillus, Auctt.*

γ. *tenuissimus*, (Mert. & Koch.): caule capillaceo e tereti-subcompresso ramosissimo; foliis angustissimis acutis cuspidatisque, sub-3-nervibus nervis lateralibus obsoletis, aveniis; spicis paucifloris. *P. pusillus*, β, *tenuissimus, M. & K. Germ.* 1, *p.* 856. *P. pusillus*, δ, *Chamiss. l. c. P. pusillus*, γ. *Fries. l. c. Kth. l. c.*

Hab. Still and flowing waters:—α in ponds and lakes, rather conspicuous; Cambridge: Lake Champlain; Seneca Lake, New York; and westward to Wisconsin (Mr. Lapham; *hb. Sartwell!*) —β in ponds, stagnant parts of rivers, and in ditches, Cambridge; Newton; and fine in Tewksbury pond.—γ Penn Yan, New York, (*Dr. Sartwell!*) I have seen but one specimen of γ, but it agrees very well with the character of the European variety, which differs from β principally in its very slender stem, and much narrowed leaves. The stem of this species is commonly more or less distinctly compressed, but in β and γ it is often nearly or quite terete; much branched, especially in β and γ; 1–2 feet long,

Leaves all membranaceous, pale green, in β and γ often fuscescent, linear, sensibly a little tapering upwards, and very shortly so at the base, which is more or less distinctly biglandulose, sessile;—in α broader, obtusish, submucronate, oftener 5-nerved, with here and there a few scattered, more or less conspicuous veins, which are most numerous in the highest, 1–2 inches long by ¼ of a line wide to a line in width;—in β narrower, more or less acute or acuminate and often cuspidate, 3-nerved, the lateral nerves commonly inconspicuous, the space next the midrib on each side more or less widely reticulate-cellulose, nearly veinless, 1¼–2 inches long by ¼ to ¾ of a line wide;—in γ very narrow, acute or cuspidate above, the lateral nerves subobsolete, veinless, shorter than in the other varieties. Stipules large for the plants, delicate, pellucid, acute, at length lacerate. Peduncles subcompressed, or nearly terete, a little thickened near the spike, half an inch to 1½ inches long. Spikes more or less cylindrical and whorled, interrupted, few-flowered, about half an inch long; or, in β and γ oftener crowded-capituliform. Nutlets obliquely elliptical, subtricarinate, a little rostrate with the short style, the back rounded-carinate slightly curved downward below the apparent base, a sunken line on each side indicating the lateral keels, the sides convex and gently sloping to the obtusish face. Exocarp thin. Putamen thick, not hard. Seed convolute-uncinate. This species is probably rather common in the Northern States. The American plants here referred to α, and β, agree generally with my European specimens, and, as well as γ, are always recognizable by the rounded-carinate fruit. The variety α closely resembles *P. obtusifolius*, an European species not yet observed in this country, but is distinguished from it by its fruit, and its 5-nerved leaves.

Potamogeton pauciflorus, (Pursh): caule compresso ramosissimo; foliis omnibus submersis membranaceis saturate viridibus anguste linearibus versus apicem sensim levissime basique brevissime attenuatis sessilibus, apice acutis, 3-nervibus, nervis lateralibus plus minus obsoletis, subvenosis; stipulis linguiformibus membranaceis teneris acutis: pedunculis brevibus compressis sub spica incrassatis spicis paucifloris capitatis subglobosis floriferis plus minus reversis, subduplo longioribus; fructibus recentibus subcompressis. dorso vel acute carinato simuato-dentato oblique ellipticis vel lato-alato dentato subrotundo-obovatis, mucronato-rostratis, carinis lateralibus obsoletis, lateribus convexiusculis in faciem vel acutam vel carinatam declivibus. *P. pauciflorus*, *Pursh Fl.* e Chamiss. *Barton Comp. Fl. Phil.* 1. *p.* 97. *Ell. Sk.* 1, *p.* 222. *Bigel. Bost. edit.* 2, *p.* 63. *Torr.! Fl. U. S.*, *p.* 198. *Chamiss. in Linnæa.* 2, *p.* 176, *t. ir*, *p.* 7. *Kth. Enum.* 3, *p.* 136. *Beck Bot.*, *p.* 386. *A. Gr.! Man. Bot.*, *p.* 457. *Wood Bot. p.* 526. *P. gramineus*, *Michx. Fl.* 1,

p. 102, e Chamiss. *P. exstipulatus*, (*Muhl.*) *Herb. Willd.* part. e Chamiss.

Hab. Ponds and slow streams; Cambridge; and common in New England; and from the eastern part of New York, (*Prof. Torrey!*) to western New York, (*Prof. Gray!*) westward to Kentucky (Dr. Short. *Hb. Torr.!*) and California, (*Chamisso,*) southward to South Carolina, (*Michaux,*) and Louisiana, (Dr. Hale. *Hb. Torr.!*) Chamisso found it also in the Sandwich Islands. Stem compressed, branched, at first mostly below, but at length very much so above, 6 inches to about 1½ feet long. Leaves membranaceous, dark-green, narrow-linear, above sensibly a little attenuate to the acute and often somewhat mucronate tip, shortly tapering at base and sessile; mostly 3-nerved, but the lateral nerves more or less obsolete and sometimes entirely so; with commonly but a few scattered veins, but these sometimes frequent and conspicuous, especially in the highest leaves; the space next the midrib on each side more or less widely reticulate-cellulose; somewhat obsoletely glandulose at base; 1–2 inches long by ¼ to ½, or, especially in the western plants, ¾ of a line wide. Stipules delicate, short, acute. Peduncles short, compressed, thickened immediately below the few-flowered, capitate, sub-globose spike, which is more or less reversed in flower but becomes erectish in fruit. Nutlets compressed, subtricarinate; the back a little curved downward below the apparent base, and sinuate-dentate; either acutely subalate-carinate, when the whole outline is obliquely elliptical, or semicircular and broad-alate, when the outline is rounded-obovate; mucronate-rostrate with the short style; the lateral keels obsolete; the sides very slightly convex, and until quite mature, punctiform-impressed at the middle; the face acutish, or in the broad-winged fruits, carinate. Exocarp rather thin; produced at the back and forming the wing. Putamen thick, not hard. Seed convolute-uncinate. The exocarp being removed the back appears more or less *acutely* carinate. The stress of difference between this species and *P. pusillus*, β, is in the fruit: though the darker color of its more constantly acute, and more venose leaves, its shorter stipules, and its short-peduncled, few-flowered, subglobose spikes, will also furnish perhaps quite reliable differences. And I have thus far found the commonly conspicuous glands at the base of the leaves of *P. pusillus*, a safe index to that species; these glands in the present, so far as my observation has gone, being either nearly or quite obsolete; as Kunth, who inserts '*eglandulosis?*' into his character, appears to have found them. The discrepancy between the descriptions of the fruit given by Chamisso and by Kunth, seems to be reconciled by a consideration of the varying width of the wing, this difference serving to alter materially the whole outline of the nutlets. In the very narrowly winged fruits,

the outline is not dissimilar from that of the nutlets of *P. pusillus*, but the sides are flattish, and the back is acute. Pursh omits, in his *Flora*, the customary mark of having seen this species living, repeating there merely the character and habitat given in Michaux's *Flora* to the *P. gramineus* of that work; and there is no specimen of it in his herbarium. Michaux's plant is therefore the *fons speciei*, and Chamisso, who had seen a single nutlet from the specimen preserved at Paris, says, (l. c., p. 178,) that though this differed a little, in its larger dimensions, from the fruit of his specimens of *P. pauciflorus* from the Sandwich Islands, both might well belong to the same species.

Potamogeton trichoides. (Cham. and Schlecht.): caule teretiusculo ramosissimo; foliis omnibus submersis membranaceis longiusculis concavo-convexis setaceo-linearibus versus apicem sensim levissime basique brevissime attenuatis sessilibus, apice acutissimis, uninerviis, aveniis, reticulato-cellulosis; stipulis linguiformibus amplectentibus acutis; pedunculis elongatis; spicis subinterruptis, vel sæpius confertis abbreviatis; fructibus recentibus oblique lunato-ovatis, dorso latiori tricarinatis, carina media semicirculari obtusiuscule subalato-carinata, lateralibus discretis obtusiusculis, lateribus planiusculis medio impressis, facie obtusa basin versus unidentata, stylo faciali brevissimo. *P. trichoides, Cham. and Schlecht. in Linnæa*, 2, *p.* 175, *t. iv*, *f.* 6. *Koch. Syn., p. 677. A. Gr.! Man. Bot., p. 457. P. pusillus, β. e part. Mert. & Koch.* 1, *p.* 857, e Chamiss. *P. pusillus, var. Oakes in sched. olim!*

Hab. Ponds. Near the Notch of the White Mountains, in the Trout-pond, abundant, and first detected there by the late Mr. Oakes, and Dr. Robbins of Uxbridge. Also in Long pond, Tewksbury. Root creeping, branched, geniculate, or the stem itself prostrate and performing the function of a root. Stem slender, terete; much- and spread-branched below, rather distantly branched above: the branches repeatedly ramulose; 12–18 inches long. Leaves rather long, delicate, pale-green; a little concave above, but appearing roundish in a cross-section; setaceous-linear, slightly and shortly tapering at base, and sensibly so above to the very acute tip; one-nerved; veinless; reticulate-cellulose; those of the stem about 2 inches long by $\frac{1}{5}$ to $\frac{1}{4}$ of a line wide, but those of the branches much smaller. Stipules rather firm, green, 3–4 lines long, largest at the lower part of the stem. The elongated, commonly simple apex of the stem serving as peduncle, and a little thickened immediately below the spike; 3–6, or more inches long. Spikes a little elongated and interrupted, but very commonly abbreviated and somewhat capitate, few-flowered. Nutlets obliquely lunate-ovate, a little compressed, tricarinate, the middle keel semicircular, narrowly winged, obtusish, sometimes a little sinuate; the lateral ones distinct, (and also sometimes sin-

uate when dry,) the sides flattish, and impressed at the middle; the face obtuse, one-toothed near the base; the style facial, and very short. Exocarp thick. Putamen thickish. Seed convolute-uncinate. I have seen no specimens of the European plant, but Chamisso's minute description, and his figure of the fruit, leave little or no doubt of the identity of ours with it. It is observable that the sinuate-dentation of the back of the nutlets, noticed in the American specimens of *P. compressus*, but not mentioned as occurring in any European species by Chamisso, is found also in the present.

Potamogeton hybridus, Michx. Since the publication of my notes upon this species, I have had an opportunity of examining the Potamogetons in the herbarium of Prof. Torrey, and have found specimens of *P. hybridus* from New Jersey, Virginia, Georgia, Alabama and Louisiana, none of which differ, so far as I have observed, materially, from the description above referred to, and all of which seem to me to confirm the characters of the fruit there detailed (as to its small size, its shape, and its distinct, sharp, often toothed lateral keels) which were relied upon as sustaining the remarkable difference of the submersed leaves, that appeared to distinguish this species from *P. Spirillus*, also there described. Chamisso considered *P. hybridus*, it would seem, to belong to the tribe *Natantes*, and he remarks that its leaves are to be regarded as bladeless petioles. But this will appear less probable on comparing it with *P. Spirillus*, (a plant unknown to the German author,) which explains the characters of the former species (somewhat obscure from its tenuity) and makes evident that both are to be referred to the section Graminifolii, and viewed, as perhaps, by the attachment of their leaves to the stipules, the connecting links between the tribes *Compressi* and *Pectinati*.

Potamogeton pectinatus, (L.): caule subtereti ramosissimo; foliis omnibus submersis membanaceis cum stipulis connatis basique vaginantibus lineari-setaceis versus apicem sensim attenuatis acutissimis, uninervibus, venosis; ligulis longiusculis scariosis demum lacero-setosis; pedunculis filiformibus æqualibus elongatis; spicis longiusculis interrupte verticillatis; fructibus recentibus oblique lunato-obovatis compressis, stylo faciali brevissimo apiculatis, dorso latiori rotundo-carinatis, carinis lateralibus obsoletis, lateribus planiusculis in faciem acutam declivibus. *P. pectinatus. L. Sp.* 183, e Koch. *Pursh! Fl.* 1, *p.* 121. *Torr.! Fl. U. S., p.* 198. *Chamiss. in Linnæa*, 2, *p.* 164. *t. iv, f.* 2. *Fries Norit., p.* 52. *Koch Syn. p.* 677. *Beck Bot., p.* 386. *Kth. Enum.* 3, *p.* 137, (excl. *P. marino.*) *A. Gr.! Man. Bot., p.* 457, (excl. *P. marino.*) *Wood Bot., p.* 526, (excl. syn.) *P. marinus, Michx., Fl.* 1, *p.* 102, e descr.

Hab. In still and flowing water. In the Connecticut in Massachusetts; and thence to the Lakes of Western New York, (*Prof. Gray!*) and Niagara Falls. In the St. Lawrence, (*Michaux.*) In Lake Ontario, (*Pursh!*) In Lake Superior, (*Prof. Agassiz!*) Southward, New Jersey, (*Prof. Torrey!*) to Louisiana, (*Dr. Ingalls, Hb. Torr.!*) Stem a little compressed, plano-convex, much branched at the base, and also above, 1–2 feet long. Leaves commonly thickish, but also occurring more delicate, somewhat channelled above and convex below, more or less setaceous-linear, sensibly attenuate above and very acute, below connate with the stipules and clasping; one-nerved; with frequent, thickish veins disposed at right angles to the margin; 2–4 inches long, by $\frac{1}{4}$ to $\frac{3}{4}$ of a line wide. Ligules elongated lanceolate, whitish, at length lacerate-setose. Pedumcles commonly much elongated, filiform, not thickened. Spikes rather long, interruptedly whorled, not many-flowered. Nutlets large, obliquely lunate-obovate, compressed, the broad back obtusely carinate, (rather acute when dry,) the lateral keels obsolete, but indicated by a slightly sunken line, the sides flattish, sloping to the somewhat acute face. Exocarp thick, wrinkled when dry. Putamen very thick, softish. Seed uncinate-curved. The exocarp being removed, the back appears rounded-carinate, (or in other fruits from the same station, acutely so, as in my French specimens,) the sunken lines on each side, which define the obsolete lateral keels, connivent below the apex of the nutlets, the sides a little convex, and very slightly, or not at all impressed at the middle, the style disappearing, and the whole outline becoming more elliptical. This description differs in some few particulars from Chamisso's, but our plants are probably inseparable, specifically, from the European. *P. marinus*, L., e Fr. and Koch, (*P. filiformis*, Nolte! and Chamiss.) a species nearly akin to this, but with rather shorter, longer-leaved stems, and small, ecarinate nuts, and peculiar to salt water, is perhaps to be detected here. I have seen a New Jersey specimen that appeared to resemble it, but it was without fruit.

Art. XXXI.—*On a New Table of the Pressure of Steam at various Temperatures;* by J. H. Alexander, Esq.

In a former Number of this Journal,* I gave the elements of a new theorem for calculating the tension of Vapor of Water at all temperatures; and presented at the same time an extensive tabulated comparison of the indications of this theorem with the results of the best experiments upon the pressure of steam. This comparison, extending between - 27° and + 435° of Fahrenheit's thermometer-scale, shewed among other things, that the pressures calculated by the theorem, agreed more closely and consistently with the mean of the observations than the experimental numbers did, themselves; and in so far, therefore, the formula was fully sustained.

A supplemental Memoir in a succeeding Number,† contained a discussion of the admitted uncertainties of divers experimental series (being also those, accepted as the best contrived and most reliable, hitherto) and of the consequent probable errors by the formula; the reasonable conclusion from all which, was that the mean probable error of this last is *less* than the actual contingent (or it may be, necessary) inaccuracies of the experiments; and therefore, that the reciprocal temperatures and pressures assigned by the theorem, were in fact more thoroughly and safely reliable than the quantities given in any single series of observations.

Accompanying this last memoir, was a short table whose argument is the pressure of Steam in Atmospheres; and it only remained, for completing the subject, to have a corresponding table whose argument should be the temperature in degrees of Fahrenheit. This I have prepared and now present. It extends from zero of Fahrenheit, for every five degrees, up to the melting point of ice; and progresses thence, from degree to degree, up to 365°, which may be considered as even beyond the limiting temperature for safe or judicious application. The pressures are given in inches of a mercurial column supposed at a constant temperature of 32° F.; but they can be converted into pounds avoirdupois per square inch very readily and with sufficient accuracy for the most of practical purposes, by halving the tabular numbers. The column of differences of elasticity for each degree, which had to be made up as one of the checks upon the arithmetical operation, has been retained and will be found frequently useful.

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* ii Ser., vol. vi, p. 210, seqq. † ii Ser., vol. vi, p. 317, seqq.

TABLE *of the Pressure of Steam in inches of Mercury at the temperature of melting ice from degree to degree of Fahrenheit's thermometer.*

Temp. in degrees.	Pressure in inch. of Merc.	Difference for 1 degree.	Temp. in degrees.	Pressure in inch. of Merc.	Difference for 1 degree.	Temp. in degrees.	Pressure in inch. of Merc.	Difference for 1 degree.
0	0,040	0,002	85	1,39	0,04	145	7,20	0,17
5	0,052	0,003	86	1,43	0,05	146	7,37	0,18
10	0,069	0,004	87	1,48	.	147	7,55	.
15	0,088	0,005	88	1,53	.	148	7,73	0,19
20	0,113	0,006	89	1,57	.	149	7,92	.
25	0,143	0,007	90	1,62	.	150	8,11	.
30	0,179	0,008	91	1,67	.	151	8,30	0,20
32	0,196	.	92	1,72	.	152	8,50	.
33	0,204	0,009	93	1,77	0,06	153	8,70	.
34	0,213	.	94	1,83	.	154	8,90	0,21
35	0,222	0,010	95	1,89	.	155	9,11	.
36	0,232	0,011	96	1,95	.	156	9,32	0,22
37	0,243	0,010	97	2,01	.	157	9,54	.
38	0,253	0,011	98	2,07	.	158	9,76	.
39	0,264	.	99	2,13	.	159	9,98	0,23
40	0,275	.	100	2,19	.	160	10,21	0,24
41	0,286	0,012	101	2,25	0,07	161	10,45	.
42	0,298	.	102	2,32	.	162	10,69	.
43	0,310	0,013	103	2,39	.	163	10,93	0,25
44	0,323	0,014	104	2,46	.	164	11,18	.
45	0,337	.	105	2,53	.	165	11,43	.
46	0,351	.	106	2,60	0,08	166	11,68	0,26
47	0,365	.	107	2,68	.	167	11,94	0,27
48	0,379	0,015	108	2,76	.	168	12,21	.
49	0,394	0,016	109	2,84	.	169	12,48	0,28
50	0,410	.	110	2,92	.	170	12,76	.
51	0,426	0,017	111	3,	.	171	13,04	.
52	0,443	.	112	3,08	0,09	172	13,32	0,29
53	0,460	0,018	113	3,17	.	173	13,61	0,30
54	0,478	.	114	3,26	.	174	13,91	.
55	0,496	0,019	115	3,35	.	175	14,21	0,31
56	0,515	.	116	3,44	.	176	14,52	.
57	0,534	0,020	117	3,53	0,10	177	14,83	0,32
58	0,554	0,021	118	3,63	.	178	15,15	.
59	0,575	.	119	3,73	.	179	15,47	0,33
60	0,596	0,022	120	3,83	.	180	15,80	0,34
61	0,618	0,023	121	3,93	0,11	181	16,14	.
62	8,641	.	122	4,04	.	182	16,48	0,35
63	0,664	0,024	123	4,15	.	183	16,83	.
64	0,688	0,025	124	4,26	.	184	17,18	0,36
65	0,713	0,026	125	4,37	0,12	185	17,54	0,37
66	0,739	.	126	4,48	.	186	17,91	.
67	0,765	0,027	127	4,60	.	187	18,28	0,38
68	0,792	0,028	128	4,72	.	188	18,66	.
69	0,820	0,029	129	4,84	0,13	189	19,04	0,39
70	0,849	.	130	4,97	.	190	19,43	0,40
71	0,878	0,030	131	5,10	.	191	19,83	0,41
72	0,908	0,031	132	5,23	.	192	20,24	.
73	0,939	0,033	133	5,36	0,14	193	20,65	0,42
74	0,972	.	134	5,50	.	194	21,07	0,43
75	1,005	0,034	135	5,64	.	195	21,50	.
76	1,039	0,035	136	5,78	0,15	196	21,93	0,44
77	1,074	.	137	5,93	.	197	22,37	0,45
78	1,109	0,037	138	6,08	.	198	22,82	.
79	1,146	0,038	139	6,23	.	199	23,27	0,46
80	1,184	0,039	140	6,38	0,16	200	23,73	0,47
81	1,223	0,040	141	6,54	.	201	24,20	0,48
82	1,263	.	142	6,70	.	202	24,68	0,49
83	1,303	0,043	143	6,86	0,17	203	25,17	.
84	1,346	0,043	144	7,03	.	204	25,66	0,50

TABLE—(Continued.)

Temp. in degrees.	Pressure in inch. of Merc.	Difference for 1 degree.	Temp. in degrees.	Pressure in inch. of Merc.	Difference for 1 degree.	Temp. in degrees.	Pressure in inch. of Merc.	Differ'ce for 1 degree.
205	26,16	0,51	265	75.60	1,24	325	186,24	2,61
206	26,67	0.52	266	76.84	1,25	326	188,85	2,64
207	27,19	0,53	267	78,09	1,27	327	191,49	2,66
208	27,72	0,54	268	79,36	1,28	328	194,15	2,69
209	28,26	0,55	269	80,64	1.30	329	196.84	2,73
210	28.80	.	270	81,94	1,33	330	199.57	2,76
211	29.35	0,56	271	83,27	1,34	331	202,33	2,80
212	29.91	0,57	272	84,61	1,35	332	205,13	2.84
213	30,48	0.58	273	85,96	1,36	333	207,97	2,87
214	31,06	0,59	274	87,32	1,39	334	210,84	2,90
215	31,65	0,60	275	88,71	1,41	335	213.74	2,94
216	32,25	0,61	276	90,12	1,43	336	216,68	2,97
217	32,86	.	277	91,55	1,45	337	219.65	3,
218	33,47	0,63	278	93,	1,47	338	222.65	3,03
219	34,10	.	279	94,47	1,50	339	225.68	3,07
220	34,73	0,65	280	95,97	1,51	340	228,75	3,10
221	35.38	.	281	97,48	1,52	341	231,85	3,13
222	36,03	0,67	282	99,	1,54	342	234,98	3,16
223	36,70	.	283	100,54	1,56	343	238,14	3.20
224	37,37	0,69	284	102,10	1,58	344	241,34	3,24
225	38.06	0,70	285	103,68	1,60	345	244.58	3,28
226	38.76	0,71	286	105,28	1.63	346	247.86	3,32
227	39.47	0,72	287	106,91	1.65	347	251,18	3.36
228	40,19	0,73	288	108,56	1,67	348	254,54	3.39
229	40,92	0,75	289	110,23	1,69	349	257,93	3.42
230	41.67	.	290	111.92	1,71	350	261,35	3,45
231	42,42	0,76	291	113.63	1,72	351	264 80	3,49
232	43,18	0.77	292	115,35	1,75	352	268,29	3,53
233	43.95	0,78	293	117.10	1,77	353	271,82	3,59
234	44,73	0.80	394	118,87	1,80	354	275,39	3.61
235	45,53	0.81	295	120,67	1.83	355	279.	3,66
236	46.34	0,82	296	122,50	1,85	356	282,66	3,71
237	47,16	0,83	297	124,35	1.87	357	286,37	3.75
238	47.99	0,85	298	126,22	1.89	358	290,12	3.79
239	48,84	0,86	299	128,11	1.91	359	293.91	3.83
240	49,70	0,87	300	130,02	1,93	360	297,74	3.87
241	50,57	0,88	301	131,95	1,96	361	301,61	3.91
242	51.45	0,89	302	133,91	1,99	362	305,52	3.95
243	52.34	0,91	303	135,90	2,01	363	309.47	3.99
244	53,25	0,92	304	137.91	2.03	364	313.46	4,04
245	54.17	0,94	305	139,94	2,06	365	317.50	
246	55.11	0,95	306	142,	2,09			
247	56,06	0,96	307	144,09	2,11			
248	57,02	0,97	308	146.20	2,13			
249	57.99	1,	309	148,33	2.16			
250	58,99	1,01	310	150.49	2.20			
251	60,	.	311	152.69	2,22			
252	61,01	1,03	312	154.91	2,24			
253	62.04	1,04	313	157,15	2,27			
254	63,08	1,07	314	159.42	2.30			
255	64,15	1,07	315	161.72	2.32			
256	65.22	1,09	316	164.04	2.34			
257	66,31	.	317	166.38	2.37			
258	67,41	1.10	318	168,75	2.40			
259	68.53	1,12	319	171.15	2,44			
260	69.67	1.14	320	173.59	2.48			
261	70,83	1,16	321	176 07	2.51			
262	71.99	.	322	178,58	2.53			
263	73,18	1,19	323	181.11	2.55			
264	74.37	1,23	324	183,66	2,58			

Formula.

p = pressure in inches.

t = temp. in deg. Fahr.

$\therefore p = \left(\frac{t}{180} + \frac{990}{1695}\right)^6$: and

$t = 180\sqrt[6]{p} - 105^\circ,13.$

Also, if

p' = pressure in atmosphere of 29,915 inc. at 32° F.

t = temp. as before;

$\therefore p' = \left(\frac{t}{317,13} + \frac{561.91}{1695}\right)^6$

$= \left(\frac{t}{317,13} + \frac{990}{2986,33}\right)^6$

and

$t = 317,13\sqrt[6]{p'} - 105^\circ.13$

Art. XXXII.—*On the Dispersion of Light;* by Lieut. E. B. Hunt, U. S. Corps of Engineers.

It is my purpose in this paper,

I. To present a historical summary of the physical theories of chromatic dispersion.

II. To prove by reference to certain astronomical facts, that the *unequal velocities* of the *different colored rays*, forming the basis of the present most received theories, cannot exist to the extent required.

III. To present an outline of a new theory of chromatic and thermotic dispersion, essentially different in principle from any hitherto developed.

The technical importance of the unequal refrangibility of different colored rays and their consequent dispersion in the prismatic spectrum, is not less than its interest as a physical fact. To correct the chromatic observation and make a truly achromatic refracting telescope and microscope, was a triumph as splendid in results as difficult of attainment. The inability of the undulatory theory clearly to explain this fact, has long been the most serious objection to its unquestioned adoption, for it is charged not with a mere failure to explain, but a seeming proof that the fact cannot be. Nothing brings us more in contact with the physical character of light than the colored spectrum, and when we observe that all nature is presenting in ceaseless variety these same mingled hues, conversing with us almost solely through their ministry, they gather a new and living interest. As to Joseph, his "coat of many colors" was an ever-speaking token of that paternal regard and fondness, which followed him in all his wanderings; so to us does the "bow of promise" and the whole "shining robe of day," tell of a creating Father, and shadow forth his kind control.

I. Newton,* after experimentally proving that the different colored rays have different refractive indices for the same medium, and that these indices are independent of any mutual action of the colored rays on each other, being constant for each in any combination of rays or media, proceeded to show how, on the emission theory, this unequal refrangibility or chromatic dispersion could be explained by the received principles of mechanics. Ascribing the whole fact of refraction to the action of molecular forces at insensible intervals, he had only to conceive, in accordance with observation, some cause of difference between colors

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* For the history, &c. of dispersion, see Lloyds Report to Brit. Association, 1834, p. 314. Whewell's History of the Inductive Sciences, vol. ii, p. 453. Herschel's Treatise on Light: Art. 564, 565, et seq.

in the time or intensity of this action. The facts required this cause to be something intrinsic in and peculiar to the several colored rays: peculiarities of media alone being wholly insufficient for an explanation. Newton ascribed dispersion to differences of size between the different colored luminous particles; the red being greatest and the violet smallest. To this a difference of identity or intensity of molecular action must be superadded, as no mere difference of volume, could, except in a resisting medium, produce a refractive difference. By M. de Courtivon and Mr. Melville, a difference of initial velocity was supposed: this, by subjecting the colored particles to molecular action for unequal times, would produce refractions varying as an inverse function of their velocities. Astronomical facts wholly disproved the hypothesis. The idea of heterogeneous particles, between which and the molecules of bodies, exist elective attractions, like chemical elective affinities, has been more widely entertained. Assuming the emission theory and excluding difference of chromatic velocities, we are forced to the admission of heterogeneous particles, either in the Newtonian mechanical sense or this elective affinity sense, which two nearly merge into each other. The emission theory hypothesis of heterogeneous particles, certainly represents the facts of dispersion.

But the theory itself, encumbered by the ideas of "fits," "sides" of rays, "rotating polarities," &c., has no strong claims on our admiration and acceptance. In truth, its explanatory powers, so far from embracing new optical discoveries as they have been developed, seem exhausted on the simple facts to which Newton applied them. Admitting the incorrectness of this theory, it is still singular that it should have served the purposes of explanation so well. We can scarcely avoid the belief, that in spite of its defects, it contains some vein of truth, and presents some fragmentary picture of nature's phases. If the views presented in this article be correct, the feature of molecular attraction on light, as the cause of its refraction, will be retained from Newton's theory, while that of emitted luminous particles is abandoned. This will effect a compromise between the emission and wave theories, by making the waves themselves, subject to molecular attraction, and that unequally according to their nature.

The fact of dispersion has been the chief stumbling block in the way of the wave theory. All attempts to explain it from this point of view, had by general consent, been unsatisfactory up to that commenced by Fresnel and completed by Cauchy. A failure to explain is compatible with sound theoretical bases, but the wave theory seemed to prove that dispersion could not exist: a conflict with fact which has been a great obstacle to its adoption. Mathematical investigations all indicated that the velocity of wave transmissions in the same medium of any density,

was wholly independent of the nature of the wave. But as refraction is ascribed to a change of velocity in passing through different media, and as each color in this change of media, entering along the same or parallel lines should pass through precisely the same succession of media, there seemed no possible reason why one ray should be more retarded or accelerated than another. Admitting Huyghens' explanation of refraction, there seemed to be no possibility of dispersion. Besides the analogy of sound, from which the wave theory is so largely drawn, is entirely averse to dispersion as due to unequal velocities: for all sounds are heard in the same original order at all distances, and have therefore equal velocities. Sir John Herschel, in alluding to this "great difficulty," says: "it must not be dissembled that it is impossible to look on it in any other light than as a most formidable objection to the undulatory doctrine." Yet the explanatory powers of this doctrine are such as to have exalted it into the list of physical generalizations.

Fresnel and Cauchy have brought forward and prosecuted the *hypothesis of finite intervals* to meet this difficulty. By supposing the interval between the ether particles, a sensible distance as compared with the lengths of luminous waves, a relation has been deduced between the length of wave and its velocity of transmission. The spectral rays having unequal wave lengths, should then have unequal velocities, retardations and deviations. This explanation turns wholly on a difference in the actual velocities of the different rays, and has no application if this difference does not exist. Assuming the correctness of the reasoning of these eminent mathematicians, its application to nature rests wholly on the question, whether the hypothesis of finite intervals be a fact; also, if the colored rays be proved to have actual equal velocities in the same medium, this hypothesis cannot represent nature. In this case too, nearly all the proposed explanations of dispersion become inadmissible. That suggested by Dr. Young and developed by Mr. Challis, of a resistance due to molecular inertia, would be excepted. This however seems not to have met with favor, and like its companions contains the defect of confounding change of velocity with change of direction.

In view of the general history of physical optics, the following propositions seem fully warranted.

1. The undulatory theory of light, in its application to the explanation of a vast range of observed optical facts, is eminently successful.

2. The Newtonian or emission theory, though perfectly representing many of the facts of light, entirely fails in many cases.

3. The unequal refrangibility or spectral dispersion of light, is the weak point of the undulatory, and the strong point of the emission theory.

4. No seemingly satisfactory explanation of dispersion under the undulatory theory has yet been given, which is not based on the hypothesis of finite intervals.

5. This hypothesis and all others now maintained, except that of the heterogeneous emission, are successful in explaining dispersion, only as they involve different velocities of propagation for the different colors.

6. If this difference of velocity be incompatible with natural facts, no theory involving it can stand without modification.

II. To show that luminous rays of different colors traverse the same medium with velocities sensibly equal, we need only to admit the contrary and trace its results. Suppose the red and violet rays to have unequal velocities of propagation V^r and V^v. Whatever else a ray of light may be, it is the trajectory of a series of impulses, which produce vision, and which take *time* in their passage from the radiant to the eye. Two ray impulses with unequal velocities V^r and V^v, simultaneously leaving the radiant, will traverse a space, S, in the same medium in unequal times, $T^r = \frac{S}{V^r}$ and $T^v = \frac{S}{V^v}$. If both the radiant and the eye are fixed, the eye simultaneously receives two luminous impulses, which left the radiant at two previous instants separated by a time $= T^v - T^r = T^{dif}$. A ray being a continuous series of these impulses perfectly alike, the eye, after both red and violet have reached it, would be acted on just as if T^{dif} did not exist, and would perceive this fact only by receiving R^r through the space T^{dif} before receiving R^v.

Let the eye receive a rapid motion, the radiant being still fixed. This motion combined with that of the impulses along R^r and R^v, will produce two resultants inclined to R^r and R^v, or astronomical aberration will result, with two values. The components of the earth's motion both along and perpendicular to these rays will be common, while the luminous motions along them are unequal. Calling V^e the earth's normal velocity, $V^e : V^r =$ the radial component of the earth's velocity, : : 1 : tang. aberration of R^r. While the tang. may be replaced by the arc, the difference of aberration of R^r and $R^v = \frac{V^r - V^v}{V^e}$. When V^r and V^v are sensibly unequal, two apparent radiants will result one red and one violet, whose angular distance equals $\frac{V^r - V^v}{V^e}$. A star emitting white light should then show as a colored spectrum with this elongation. Or as the actual maximum aberration is $20''.5$, we have $\frac{V^r + V^v}{2} : V^r - V^v : : 20''.5 :$ colored elongation. This spectral elongation would be distinctly visible if it exceeded the

minimum observable distance. But no such appearance is observed; hence a very low limit of possible values for $V^r - V^v$ is fixed: a value obviously too small to explain dispersion.

If a rapid motion be given to the radiant, a like spectral elongation will result from assigning unequal velocities to the different colored rays. The red ray would show a position of the radiant $T^v - T^r$ units of time later than that chosen by R^v simultaneously received. This spectral distortion would tend to correct or magnify that due to aberration, according as the earth and radiant have like or opposed motions. This should cause distortions of planetary discs and cometic nuclea, actually unobserved.

All instantaneous events, like eclipses and emersions of Jupiter's satellites occurring at great distances, should if $V^r > V^v$, finally disappear in violet, and first appear in red gradually growing white. The eclipses and emersions of Jupiter's satellites are so sharply defined, that they serve well for determining longitude. About 49′ 23″ may intervene between an event at Jupiter and our perception of it. About $1^h\ 26\frac{1}{2}'$ may pass after an eclipse or emersion of Saturn's satellites, before we see it. Yet their almost instantaneous transitions between light and darkness reveal to us no long lingering violet or swiftly rushing red.*

For fixed stars situated beyond the parallactic limit, the time required for propagating their light to us cannot be less than three years, but may be indefinitely greater. The star Algol or β Persei, "is usually visible as a star of the second magnitude, and such it continues for the space of $2^d\ 14^h$, when it *suddenly* begins to diminish in splendor, and in $3\frac{1}{2}$ hours is reduced to the fourth

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* After maturing in my own mind the previous ideas, my attention was attracted to the subjoined passage in Lloyd's Report, already mentioned. Why its applicability to a difference of chromatic velocities in all theories, was not perceived, I do not see.

"M. de Courtivon and Mr. Melville proposed to account for the dispersion of light by a difference in the initial velocity of the molecules, the red being swiftest and the violet slowest. But were such the cause of the phenomenon, the dispersion should be proportionate to the mean refraction. Indeed the hypothesis was abandoned almost as soon as proposed. Its authors had foreseen the consequence that, in the eclipses of Jupiter's satellites, the color of the light should vary just before immersion, and after emersion; and the existence of such an effect in the degree indicated by theory,† was completely disproved by the observations of Mr. Short. Another consequence of such a difference in the initial velocities of light of different colors is, that the aberration of the fixed stars should also vary with the nature of the light, and each star appear as a colored spectrum, whose length is parallel to the direction of the earth's motion."

† "The duration of this change, according to Mr. Melville, should amount to thirty two seconds, the velocities of the light of different colors being inversely as their refractive indices. This principle, however, as M. Clairaut has shown is obviously incorrect. It will easily appear that the initial velocities must vary inversely as the quantity $\sqrt{\mu^2 - 1}$, in order to account for dispersion; and that the duration of the expected phenomenon must be even greater than that assigned by Mr. Melville."

magnitude. It then begins again to increase, and in 3½ hours more is restored to its usual brightness, going through all its changes in $2^d\ 20^h\ 48^m$ or thereabouts."* Light occupies more than 7,500 times as long in reaching us from the parallactic limit beyond which Algol lies, as Algol does in changing between its maximum and minimum brightness. If we suppose V^r to be be 1-7500th greater than V^v, the red maxima would reach us simultaneously with the violet minima and conversely. Even this value would completely confuse the star's periodicity; and by increasing it, this peculiarity would be rapidly obliterated. These varying phases, marked with no chromatic changes or confusion, show beyond appeal that the extreme spectral elements of the light from Algol, cannot have velocities of transmission differing by even near 1-7500th their mean. How utterly incompetent then is any possible difference between the velocities of the different colored rays to explain dispersion. In the chromate of lead the dispersion is about one-fifth of the maximum refraction: compared with which any possible difference of chromatic velocities along the same line of media is wholly insignificant.

It seems needless farther to accumulate evidence of the fact that the rays of different colors, have *in nature*, velocities too nearly equal ever to serve for the explanation of dispersion. If M. Cauchy has shown that the hypothesis of finite intervals, yields sensible differences between their velocities, *it conflicts with facts*, and must retire from the domain of *physics* to that of *mathematics*. A powerful direct argument against this hypothesis as a fact in nature, is furnished by Ehrenberg's microscopic investigations into infusorial physiology. By a combination of actual measurements and physiological analogies, he concludes† that in certain cases of young monads, "the partitions of these monad-bellies will be but 1-4,800,000 to 1-6,400,000 of a French line in diameter, &c. I have besides seen rudiments of eyes in the monads to which I have given the name of *Microglena Monadina*, and which are 1-192 of a line in diameter. These often fire-red eye-points, appear in large infusoria, to be a fine granular red pigment, but whose granules perhaps first covered by many fine pigment granules, are small *lenses*, &c.; and although I will not lay particular stress on the fineness of these parts, yet the existence of eyes, however rudimentary they may be considered, allows of the possibility that even in the smallest species they may be present, and tends to lead us to a not so proximate finity of organic molecules; it may even give a *useful hint for considerations on the elements of colors and the theory of light*." This

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* Sir J. F. W. Herschel, Treatise on Astronomy.

† Taylor's Scientific Memoirs, vol. i, Art. 28, p. 574.

distinguished naturalist has accumulated many equally striking proofs of the minuteness of this and other types of organic existences. More than 1500 of those "partitions of monad-bellies," would be required to make up by their *thickness*, *the mean length of a luminous wave*, or 1-50,000th of an inch. And can we doubt that these partitions are actually organized and that these eyes actually see? And does any one suppose the particles of ether, by which such vision must be effected, larger or more widely separated than atoms? But the length of a wave in a solid must include many thousands of atoms. The more we ponder on these *facts*, the more completely inadmissible does the physical hypothesis of finite intervals become. Not only does it lead to a result conflicting with fact, but it is, in itself most difficult to concede. Are we not then, in view of all the facts, justly entitled to infer, that *dispersion remains unexplained in the undulatory system.*

It may seem an inexcusable rashness, to express dissatisfaction with a demonstration so long honored, as that given by Huyghens for the law of refraction. Yet thinking that, though clear and sound and beautiful in mathematics, it is radically unsound in mechanics and wholly false to nature, I would ask a candid hearing to an honest argument. This demonstration turns on the retardation of velocity of plane waves entering a denser medium, with its converse, and on the composition of the primary wave by the series of secondary waves.

The wave theory, no less than that of emission, makes light to consist in a series of mechanical impulses, whose general trajectory in the same medium, is rectilinear. Now a simple and direct *retardation* or *acceleration* of such an impulse could not *change the direction* of its trajectory: another force or impulse must combine with this in order that its course may be broken or curved. I see not how refraction or flexure of luminous trajectives can result from mere retardation. Change of velocity cannot of itself produce change of direction. Refraction takes place at the dividing surface of media. If any oblique action be ascribed to such a surface as an elastic surface of impact, it should be to produce a flexure in the contrary direction to the observed refraction. Assuming a plane wave, perpendicular to a beam, as made up of an infinite number of elementary impulses, and obliquely incident on a denser or rarer medium; each impulse should according to all mechanical principles, continue on in a straight line, falling behind or advancing beyond the uniformly moving perpendicular plane, according to the time and rate of retardation or acceleration. The actual surface of impulses would thus become oblique to the direction of the beam, this direction remaining constantly unchanged. The postulate that the direction of the ray and the normal to the wave are identical, is whol-

ly unproved, unsustained by analyses and mechanics, and hence inadmissible.

Again the possibility of spherical waves of sensible intensity in all directions, like these imagined as secondary waves, is by no means clear. An impulse received by a surface atom or particle may give it a vibratory motion *in one direction, but not in all.* How can an equal intense wave be thrown off perpendicular to this line of vibration? These atoms and particles seem to be mere media of transmission for previously existing impulses, along their lineal direction of impact. Instead of *spherical secondary* waves of ether, the case seems to demand vibrating ethereal columns, much like sonorous vibrations in pipes. The rectilinear propagation of light, is only explicable on the wave theory by supposing the lateral oscillation a mere nullity. The exterior rays of a beam should otherwise create by their lateral action, new luminous waves not destroyed by interference. This cause could destroy only those lateral waves formed in the body of the beam. Besides, why should secondary waves be produced at surfaces and not equally through the whole mass of media? Or if all particles do produce such waves, why is not the side of a beam of rays in a material medium as luminous as its end? If all do not produce them, *where are the secondary waves in atmospheric refraction?*

But the objection drawn from dispersion has still greater force. The explanation of refraction, must from the nature of the case, contain that for dispersion when the difference between colors is given. That of Huyghens entirely fails of this. It does what is worse; admit it, and it proves that dispersion cannot exist; for facts show that the different colored rays have velocities sensibly equal in the same medium, and must therefore be equally refracted along the same line of media.

Huygheus' demonstration seems to me defective, not in its mathematics, but in its conflict with mechanical principles and observed facts. Geometrical construction and physical mechanics are independent provinces: the admission of a mathematical element not entering nature or the exclusion of one *actually* entering it, may lead to results wholly foreign to fact. The admission of the *element of velocity as the cause of refraction*, seems the fundamental error which has created the whole difficulty with dispersion. *Change of velocity is not change of direction*, and even though it could produce it, dispersion would demand an inequality of chromatic velocities which astronomy, from its celestial throne, emphatically denies. A position of dissent from generally received opinions is not to be coveted. Yet in matters of natural science the honest question is, Not, what says Paul or Aristotle, but what is the fact. Respect for great names, involves no obligation to cloak error, however honorable its pater-

nity. Much do I admire and respect Huyghens and his successors; still more do I admire and respect truth, and this would I exalt by eliminating error.

III. A brief outline of my own views of refraction and dispersion will conclude this article. Having been, for many months, engaged in comparing with nature, the results mathematically deducible from a particular physical law far exceeding in generality any yet developed; and having reached the subjoined views, solely by deduction from this law, it seems well here to state it, with its data and some of its consequences. DATA. 1. Matter is of *two kinds*, generically distinct: a chemical *atom* being the unit of one, and an *ether particle*, that of the other. 2. Particles are indefinitely smaller than atoms, and all particles are identical in form, force and volume. 3. A particular species of atoms, characterizes each chemical element; all individuals of each species being perfectly alike in form, force and volume. 4. All atoms and particles are immutable in form, force and volume. 5. Each atom and particle has inertia and hence maintains constant equilibrium. LAW.* *Material generic* LIKES *repel and* UNLIKES *attract each other inversely as the square of their distances.*

Under this law, each atom in an ether medium, forms an ether atmosphere, very dense at its surface, but soon becoming evanescent. *A molecule is an atom with its ether atmosphere.* Masses, gaseous, liquid or solid, consist of such molecules in mutual equilibrium. Molecules must attract or repel each other inversely as the square of their distance, (an approximation like the law.) Gravitation between masses is the resultant of the indefinitely great number of evanescent attractions between their component molecules. Cohesion is the resultant of the finite number of indefinitely great molecular attractions acting within the sphere of attractive evanescence. Gravitation and cohesion result from the same primary force, acting through sensible or insensible distances. Molecular repulsion is an *elastic ether tension* along the dividing surface between molecules, maintained by the converging atomic attractions on ether in their intervening spaces. A constant balance exists between this elastic tension and cohesion. Latent heat is molecular ether; sensible heat, disengaged ether, free to flow as air in wind; radiant heat *ether-transmitting waves*, and light ether non-transmitting waves. Crystallogenic forces, capillary attractions, elasticity, chemical affinity, statical and dynamical electricity with electrolysis, dia-magnetism, (magnetism I find the most refractory subject,) all receive clear and harmonious explanation under this one mechanical hypothesis.

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* This law requires modification when applied between two units so near together that their lines of force action cannot be taken parallel in determining the resultant.

So unlimited and universal have I found its explanatory powers, that it is hard to resist the conviction of its being a physical verity. But wider still must its sphere of contact with nature be pushed, before it can be unhesitatingly pronounced, *a fact.* Yet has it already, for my mind, poured over nature so copious a flood of light, and revealed in the universe so profound a design, so sublime a system of legislation, so beneficent a group of most beautiful adaptations, that I have lost the power of neutrality and cannot but wish its truth. A single detached inference from a long connected series, is here presented in the following views of refraction and dispersion; views, which without the aid of the above law could scarcely have crossed my thought.

Any wave in an elastic medium, must have a portion of its mass denser than the surrounding medium. Consequently when the particles or molecules of this fluid have assumed a mutual equilibrium under the action of any local incessant force of attraction, *the waves themselves must be attracted.* In air at rest under terrestrial gravitation, a sonorous wave suddenly propagated, having a portion necessarily denser than the surrounding medium, is like a heavy floating body at each successive instant of time, and should therefore fall below a rectilinear course, in its actual trajectory of propagation. Suppose such a pulse discharged from the bore of a cannon and like ether pulses to be propagated only along its rectilinear course: it would describe a very flat projectile curve, by falling below the bore prolonged. The excess of density of the pulse only would cause this falling, for the air is buoyant—the amount of this excess divided by the mass of the pulse, would determine the distance fallen through in any time. This ratio would enter, in comparing the heights fallen through by different pulses. The constant change of particles in the pulse would not affect the result, for the action and composition of emanative force is instantaneous and incessant.

Refraction, I explain in a similar mode. The chief portion of the space in ordinary bodies is occupied by molecular ether, whose density in axial molecules based on axial atoms, and composing axial crystals, is along the dividing surfaces and through the interspaces, primarily dependent on the atomic axes, and secondarily on the molecular and crystalline axes. Take a medium in molecular equilibrium: any wave in the surrounding ethereal medium is attracted towards it like a buoyed heavy body; and though the particles of the wave are constantly shifting, all impressed attractions will be instantly and continuously combined with the wave impulse and so transmitted. A pulse propagated along a line will thus be deflected whenever the resultant of lateral attractions is inclined to its course as in the case of oblique incidence. This pulse being in a buoyant medium, it is only the action due to its excess of density over surrounding ether which

will deflect it. This excess and consequent deflection, being dependent on the nature of the wave, should vary with the color of the ray in light. This excess divided by the entire pulse and multiplied by a particular function depending on the time of action and intensity of the deflecting resultant, would measure the refraction. The physical elements entering are, the intensity of atomic attraction for the medium, and of repulsion between particles; the atomic radius on which the sphere of efficient action depends; the velocity of light which with the atomic radius will give the time function; and the specific densities of the incident waves, on the differences between which dispersion depends. The atomic or molecular attraction expressed in a series, after reaching a moderate number of terms, each counting one molecular diameter, becomes relatively very small, and the remainder of the series may be neglected in its summation—that is, molecular attraction becomes evanescent before reaching a sensible distance; its curve having both of the co-ordinate axes as asymptotes, when one is an axis of distance and the other of force. This is true if we even take the molecular diameter as great as the limit which observation shows it cannot actually exceed. A ray pulse then, obliquely incident, is attracted sensibly when it reaches an insensible distance from the refracting medium, and the more so as the pulses become specifically denser. The law of refraction and the values of the refractive index result as in the heterogeneous emission theory of Newton. The irrationality of dispersive refraction would follow an inequality between the atomic constants of media. The connection between density and refraction at once appears, and the chemico-mechanical peculiarities of oxygen even furnish a glimpse of the cause of the high refractive indices of inflammable media.

Whatever be the particular character of ethereal waves, they must, under the law, be subject to atomic attraction. To enter into an analysis of their mechanical peculiarities, is not here essential, nor have I the mathematical attainment, so difficult a subject demands. This would of course include heat waves, waves of chemical action or any others which exist; all of which having a specific excess of density must undergo attraction. The transversal vibration of luminous rays, is abundantly proved, and neither seems to touch or be touched by what has preceded. The difference between colored rays is in their amplitude of undulation, the violet or rather the lavender being shortest, and the red being longest; the former must be specifically densest, as being most refracted—the heating rays being still denser.

The ideas here so imperfectly sketched, combine, as is obvious, some points of the Newtonian and wave theories of light. Assigning to light the same mechanical nature as the latter, the reason of refractive deviation is derived essentially from the former.

In reality forming a compromise between the two, what about these views is peculiar, came deductively from another independent source. I submit them with no wish for their adoption if they do not bring us nearer to nature. If there be error in them, time and criticism will eradicate it; if truth, science will appropriate it and thus be relieved from a present reproach. Finally and with regret must I own, that my mind is too much overtasked to permit of now making that clear and full development, usually and justly demanded in support of new views.

West Point, N. Y., Feb. 9, 1849.

ART. XXXIII.—*Polarization of Galvanic Light;* by CHAS. G. PAGE, M D., Prof. Chem. National Med. College, Washington, D. C., Examiner of Patents, P. O. U. S. A.

HAVING seen it stated* upon the authority of Arago, that the light of the galvanic arc, like that from incandescent gas was not polarizable, I have been induced to repeat the experiment with a view of testing for my own satisfaction, a principle so important in a theoretical point of view. The experiment was briefly performed and only with reference to the simple fact itself. The battery employed was a Grove's, of fifty pairs, platinum plates four inches square and double surface of zinc. By means of a Nicols prism and one reflexion from a plate of mica, the light from the arc between the charcoal points was distinctly polarized. Its property in this respect was much more decided when the arc was first formed than when it had continued for a few seconds. It may be observed, that when the electrodes are first withdrawn the arc is very intense, and does not rise in the arched form immediately; but as soon as the charcoal points have become intensely heated, the arc becomes elongated and rises, from the upward current of air, and the upper portion of the arc is then feeble in intensity. This upper portion did not appear at all polarizable upon a single reflection, but upon two reflections was decidedly so.

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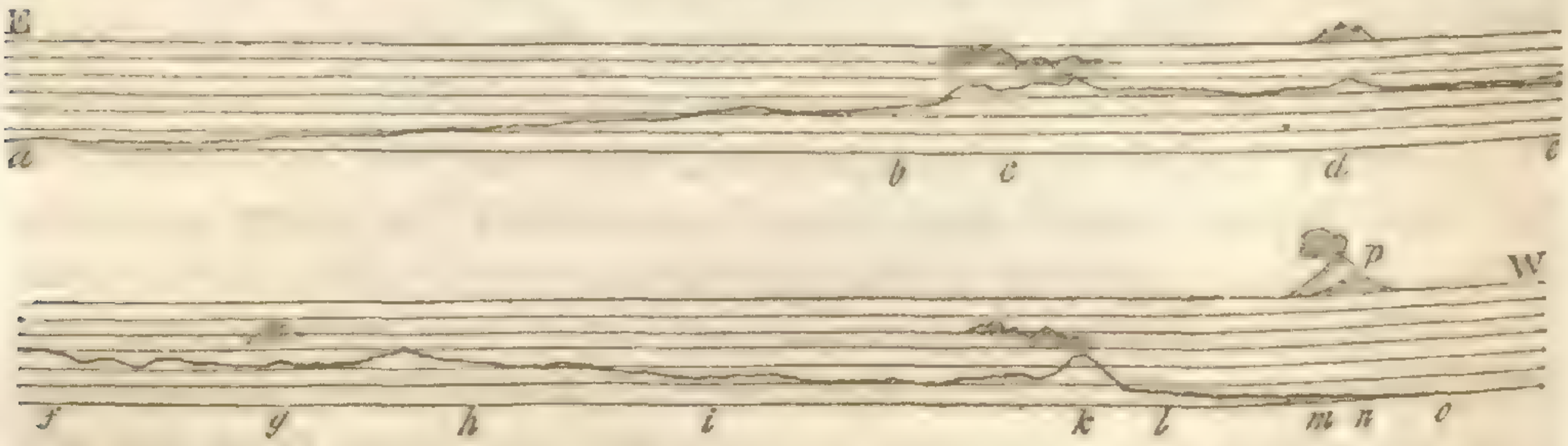
* Being poorly supplied with journals and very much occupied in official labors, I have been obliged to take the statement as I find it in several works of high repute upon the subject of galvanism, &c.

Washington, Feb. 19, 1849.

ART. XXXIV.—*Observations on some points in the Physical Geography of Oregon and Upper California;* by JAMES D. DANA.*

THE heights of the Rocky mountains which form the natural division between the territory of Middle and Western America, range along a nearly north-northeast course at a distance of six to eight hundred miles from the Pacific coast. These mountains properly include the whole breadth of country west of the Mississippi plains. The swelling of the land begins from western Missouri and very slowly rises with a slope not exceeding seven or eight feet to the mile, until it reaches an elevation of five to eight thousand feet. About the summit the surface becomes broken with ridges that rise still higher by three to six thousand feet, and the Wind River mountains, according to Fremont, stand with their bleak tops 13,570 above the sea. The traveller makes his journey by the South Pass,† without an ascent beyond 7,490 feet, and the difficulties are so slight that loaded wagons may be transported across. Thence after a while a descent is commenced, and although hills and mountain ridges are encountered, the surface, viewed in its wide extent, continues to decline to the ocean. The accompanying sections, one from Fremont,‡ the other from Emory,§ are excellent illustrations of this great feature in the physical geography of the west. The ridges at top



Profile of the route from the mouth of the Kansas to the Pacific, by J. C. Fremont, in 1843. Vertical scale to horizontal as 30 to 1. The intervals between the horizontal lines are each 2,000 feet; *a*. Mouth of Kan-sas River. *b*. St. Vrain's Fort. *c*. Laramie River. *d*. South Pass. *e*. Dividing range. *f*. Beer Springs. *g*. Great Salt Lake. *h*. Fort Hall. *i*. Crossing of Snake River. *k*. Blue Mountains. *l*. Fort Wallawalla. *m*. Dalles. *n*. Cascades. *o*. Fort Vancouver. *p*. Mount St. Helen's.

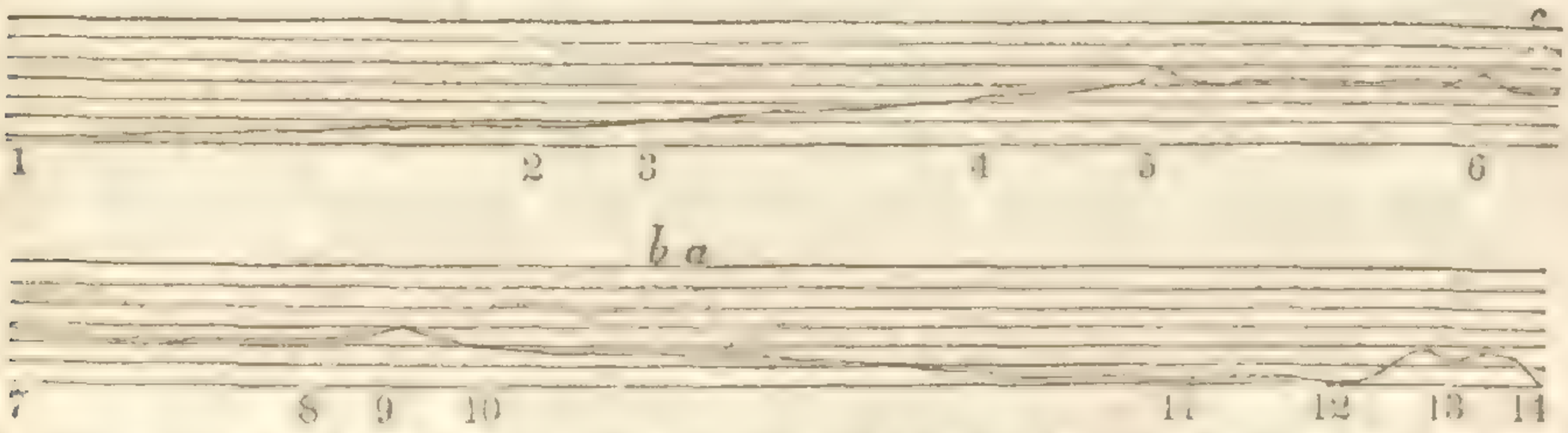
* In part from the Author's Geological Report of Exp. Exped. under Capt. C. Wilkes, U. S. N.

† The South Pass is at the headwaters of the North Fork of the Nebra-ska or Platte River. Lewis and Clarke's Pass is at the headwaters of the Jefferson river, a branch of the Yellow Stone; it is covered with snow.

‡ Rep. Expl. Exped., to the Rocky Mountains, in 1842, to Oregon and California, in 1843, 1844; by Brevet Captain J. C. Fremont. Washington, 1845. See this Jour., iii, 192. 1847.

§ Notes on a Military Reconnoisance from Fort Leavenworth in Missouri, to San Diego in California, in 1846; by Brevet Major W. H. Emory. See this Jour., vi, 367, 1848.

and over the sides are but crests or embossments on this great swelling elevation; its whole breadth exceeds fifteen hundred miles.



Section from Fort Leavenworth, Mo., by the Gila, to San Diego, on the Pacific, by Brev. Maj. Emory; scale as in the preceding figure. 1. Fort Leavenworth. 2. Pawnee Fork. 3. Jackson's grove. 3 to 4. Valley of the Arkansas. 5. Raton Summit. 6. Santa Fe. 7. Rio del Norte. 7–8. Valley of the R. del Norte. 9. Ben Moore. 10–11. Valley of the Gila. 12. A Salt Lake. 13. California Mountains. 14. San Diego, on the Pacific. *a*. Mt. Turnbull. *b*. Mt. Graham. *c*. Zandia.

Such is the elevated *Pacific* border of our continent. On the east, the Appalachians, an humbler range extending from Maine to Georgia, form the *Atlantic* border. Between the two lie the vast plains of the Mississippi, a river stretching its arms on one side far among the Atlantic heights, and on the other reaching to the Rocky mountain summits.

By these great natural features, the continent of North America is divided, as has often been stated, into (1.) an Atlantic slope, one to three hundred miles in width, (2.) a middle section between the summits of the Appalachians and Rocky range, fifteen hundred to two thousand miles broad, and (3.) the Pacific slope already alluded to. The last of these divisions constitutes North Western America. Its extent of surface from latitude 49° to the Gila, is about 867,541 square miles; of this 526,078 belong to the recent acquisition from Mexico.*

In the following pages, we remark:—I. on the peculiarities of the coast line; II. on the mountains and their courses; III. on the general courses and characters of the valleys and rivers; IV. on the distribution of forest vegetation and V, its relation to the climate. We do not propose to enter minutely into geographical details, but rather to touch upon such facts as illustrate certain prominent points in the physical geography of the territory.

I. *The Coast.*—The first thing that strikes the eye on a map of the territory is the peculiarity of the coast line, and its near parallelism with the mountains. Along by Mexico and California the coast trends nearly northwest-by-north, or more correctly N., 38° W. At the parallel of 40° it bends north, pursues a northerly course as far as the straits of De Fuca, just beyond 48° N., and then trends off again to the northwest-by-north parallel nearly with the California line. Although little more than an

* Message of the President U. S. to Congress, Dec. 5, 1848.

approximate parallelism to a range seven hundred miles distant is to be expected, it is interesting to observe that the Oregon portion, having the north and south course, has, according to the best maps, a parallel representative in the Rocky range; and if the map is held so that the coast and mountains have a horizontal position, the parallelism will appear somewhat striking;—the north and south line in the mountains beginning as it should about 4° north of its commencement on the coast.

South, toward Panama, the trend of the mountains and coast becomes more westerly, bending around to N. 62° W.

To the south of the straits of De Fuca, the outline of the coast is but little varied by bays. The only great indentation is made by the Californian gulf. This gulf, (the sea of Cortes, and Vermilion sea of the early Spaniards,*) sets into the land abruptly between 20° and 23° N., and then pursues a northwesterly course, parallel with the coast to 32° 20′, just inside of a range of mountains, making a total length of seven hundred miles, with an average breadth of one hundred miles. North of the Californian Peninsula lies the bay of San Diego, a good land-locked harbor four or five miles long, considered by Emory to be among the best retreats for shipping on the coast. Monterey farther north near latitude 36° 38′ is an open roadstead. The bay of Francisco† in latitude 37° 48′ ranks next in size to the Californian gulf. It

* This gulf was discovered by a vessel detached from the Expedition of Cortes in 1533, and Ximenes the commander was murdered soon after. Hernando de Grixalva entered it in 1534, and Cortes in 1536. The Coloracio was first discovered by Padre Francisco Kino in 1700. Until the middle of the 17th century, the peninsula was supposed to be detached from the main land, and called *Islas Carolinas*. It was shown to be a peninsula by Francisco de Ulloa in 1699, and also by Eusebius Kino in 1701. The country adjoining the gulf on the east was the Nueva Gallicia of the Spaniards, including the subdivisions, (commencing on the south,) Xalisco, Chiametta, Coulhacan, and Cinoloa, together with Guadelajara, Zacatecas, and Cibola, beyond in the interior; the last mentioned lying a little to the north of east of the head of the gulf. It is said of Cibola, that it yielded cotton wool, "by reason whereof the men and women wear better apparel for the most part than elsewhere." The Pijmos and Maricopos tribes of the same region, on the Gila, visited by Emory, cultivate cotton. Some ruins of buildings in that territory are attributed by E. G. Squier, on apparently good evidence, to the early Cibolans.

† This bay is supposed to have been first entered by Sir Francis Drake in 1578. He surveyed this coast up as far as latitude 48°, and called it New Albion, from seeing white cliffs near Point (Punta) de los Reyes, a few miles northeast of Francisco. June 17, he entered what he describes as a large bay and remained there for some time; and as this is the only place on the coast which at all answers to his description, or could have afforded him good anchorage for the time he was there, it has been supposed that he erred in his determination of its latitude, which he places in 38° 30′, instead of 37° 48′. The bay was discovered again in 1595 by a Spanish ship called San Augustin. Sebastian Vizcaino surveyed the coast in 1603, and discovered the harbor of San Diego. The coast from 40° to 44° was first explored by Juan Cobrillo, in 1542, and Cape Mendocino was named by him in honor of Don Antonio de Mendoça, then viceroy of New Spain. He failed of discovering the Columbia river, which was not entered till 1792, by Captain Robert Gray of this country, in the ship Columbia.

The town of Francisco is south of the neck that forms the entrance to the bay, about four miles from the sea.

opens through a passage one mile wide and five long, bounded by high hills, and then expands east and south into two broad, deep arms, each about thirty miles long and two to twelve miles wide. The southern arm has the trend of the coast. North of Francisco, there is a small bay at Bodega near 38° 20′, another called Gray's Harbor in 46° 50′, and the entrance to the Columbia in 46° 20′. The Columbia has a mouth seven miles in width, and the waters within afford good anchorage though reached by a somewhat difficult channel, which is wholly impassable in bad weather.

It is thus seen that from the Californian peninsula to latitude 48°, the outline of the coast is comparatively even. We are especially struck with this unbroken character, when we consider that the coast is closely bordered by high land, and thus differs widely from the Atlantic side of the continent.

North of 48°, there is a remarkable change in its features. In the first place, the continent is abruptly narrowed one hundred and fifty miles, and Vancouver's Island and others appear as the exscinded fragments. Moreover, instead of a gently undulating shore-line, the coast is cut through by a large number of narrow channels, running far into the land, like the fiords of Norway, and so deep and abrupt. that large vessels may sail with their yards amid the foliage of the shores, or rub their sides against their rocky outline, before the keel touches bottom. These deep but narrow channels have the most irregular forms, often extending to a length of fifty or sixty miles, and by their intersections making a complete network of water, for internal navigation. On a map, the intersecting channels look like a fringe to the coast—a fringe thirty to sixty miles broad. After entering the straits of De Fuca, south of Vancouver's Island, and sailing one hundred and fifty miles, some of these branching fiords extending south are reached; and a vessel bound to Nisqually winds along through Admiralty Inlet for another one hundred miles before reaching that harbor. These still inland channels are often bounded by lofty shores, sometimes rising into palisades, which are densely covered with forests.

These fiords prevail along the coast to the Russian settlements; islands are also numerous along the whole distance, varying in size from points of rock to the dimensions of Vancouver's, which measures nearly three hundred miles in length, and averages forty in breadth. The islands too have their deep fiords, especially on the oceanic side.

It is interesting to observe in this connection, that similar fiords occur upon nearly all coasts in corresponding high latitudes, while at the same time, the world over, they are almost wholly absent in the lower temperate and torrid zones. On Eastern America, the coast is singularly even in its outline until approaching

Maine. But north of latitude 43° even to Greenland, as any good map will show, the fiords are numerous, deep, and intricate in their ramifications. In South America, beyond the parallel of 42°, they begin to characterize the coast, especially the western, and long narrow channels of water become exceedingly numerous. Tierra del Fuego is cut through by them and severed into many parts. Moreover, Chiloe and numerous islands stand off the coast like Vancouver's and others of northern America. *North* of 42°, the coast has few bays and consequently an even outline.

In Europe, the fiords of Norway and the deep bays of Scotland are well known; the coast contrasts strikingly with the outline of France, Spain, and Africa. The African continent does not reach below lat. 36° and has a simple outline throughout.

There are then certain fiord latitudes—or *a fiord zone* for the globe, both north and south of the equator. New Zealand and the Auckland and other islands partake much of the same character, and are the only lands in the southern hemisphere besides the extremity of America, which reach into the southern fiord zone. These facts lead to interesting conclusions respecting extended areas of subsidence encircling our globe; for the fiords may be shown to be former valleys of the land now filled with the sea: but we pass on with this bare allusion to the subject.*

II. *Mountains.*—The parallelism between the coast and the line of the Rocky Mountains has been remarked upon. The same parallelism characterizes a large part of the great features of the surface.

1. The most prominent of the lofty dividing lines of heights, lies about 150 miles from the coast and separates a Western section from the interior of the territory. It is called the *Cascade Range* in Oregon, from its crossing the Columbia at a place named from its rapids, the Cascades. In California, the Cascade range gives way to another ridge,—the Sierra Nevada or Snowy mountains. The two are properly one long chain of mountains; yet instead of being continuous, the Oregon range gradually dies out in Northern California, while the Sierra Nevada is rising to its snowy altitude on a meridian a little farther to the east, exemplifying a common feature of the constituent parts of mountain chains—their interrupted continuity with overlapping ends, rather than a direct lineal course;—a feature which if mountains were more carefully studied, would be oftener discovered and marked on our maps.

The Cascade Range has a nearly north and south course. Although in general more than one hundred miles from the sea, it approaches the coast near Puget's Sound, and obviously because

* Geol. Report Expl. Exped., p. 675.

the waters of the ocean here have made a deep inroad into the land, rather than from a change of direction in the range. Its limits to the north are not fully ascertained, yet from the best information at hand, it appears to reach far into the Russian territory. It constitutes a barrier to commercial intercourse with the coast except along the single great highway the Columbia. Fraser's river, near latitude 49°, has also obtained a passage through these mountains; but it plunges along in a succession of cataracts.

In the course of the six hundred miles from Fraser's River to the Sacramento, latitudes 50° to 40°, the range contains seven snowy peaks, varying from *ten* to *fifteen* or *sixteen thousand feet* in height,—three north of the Columbia, and the others south. Commencing at the north, they are *Baker*, *Rainier*, *St. Helens*, *Hood*, *Jefferson* or *Vancouver*, *McLaughlin* or *Pitt*, and *Mount Shasty*.

The main body of the Cascade range in Oregon is not over five or six thousand feet in elevation. Its heights are therefore but hills in comparison with the lofty cones above enumerated which rise out of the chain. In no part of the world, not even beneath the Andes, has the writer been as deeply impressed with the sublime in mountain scenery, as when in sight of these towering peaks. There are no rival heights around: they stand alone in solitary grandeur, wrapped about with perpetual snows. Mount Rainier is in full view from the plains of Nisqually. Mount St. Helens forms one of the landmarks seen in approaching the coast. It is not less than 15,000 feet in height, and has been estimated at 16,000 feet; the snows form an unbroken mantle descending half way to its base. Mount Hood, of somewhat less altitude, is in sight from Vancouver. It stands majestic among low crouching hills, with rugged frowning features.—its summit enveloped about with a ragged coat of snow that half covers its black rocks. Mount Shasty is another of these hoary peaks: a view of its double summit is given at page 250. All these cones were once active volcanoes, and Rainier and St. Helens are said still to give off vapors and occasional showers of ashes. Intermediate parts of the range consist of granitic, hornblende, talcose and other rocks.

The Sierra Nevada has a greater average altitude than the Cascade range, and to a large extent is covered with snows. We are not yet informed whether any of its peaks rise into solitary cones, like those of Oregon. But the information obtained renders it probable that they consist largely of granite and slate rocks. The pass travelled by Fremont, near the head of the American Fork, in latitude 38° 44′, was found to be 9,338 feet high—two thousand feet higher than the South Pass of the Rocky Mountains—and points in the range near by, rose above him several thousand feet. Again, at the head of Salmon Trout river in

latitude 39° 17′ 12″, "the usual emigrant pass," the height was 7,200 feet. The same range where passed by Emory, east of San Diego just north of 33°, was little over 3,000 feet in altitude. The same mountains continued south, constitute the range of heights forming the Californian peninsula.

We pass now from these brief remarks upon the great dividing range of the territory to the sections east and west.

2. The mountains of the *Eastern section* have in general a parallelism with the Rocky chain, or else a direction *transverse* to this course. The Blue mountains, lie nearly parallel with the Cascade range, and bound the region of the Southern fork of the Columbia (Lewis or Snake river) on the west. North of this fork the range ceases; but beyond the northern Columbia other ridges continue its northward course. These mountains are eight to nine thousand feet high, and four thousand feet at the pass. The Grand Rond is a large circular valley in the mountains measuring fifteen miles by twelve in its diameters; it is a fertile prairie shut in by high walls of basalt and situated about three thousand feet above the sea.

South of the Blue range, between the districts of Snake river and the Colorado, a vast territory four hundred miles in longitude by two hundred and fifty in latitude, is called by Fremont, "the Great Basin"—a region of lakes without outlets, of few rivers, and these without mouths, of salines and salt efflorescences,—yet of some green spots amid wide regions of aridity. Even here, according to the map of this explorer,* the mountain ridges of the Basin, rising two to five thousand feet above its level, have generally a north and south direction. The courses of the limiting ranges of this great area are yet to be determined. Crossing the Sierra Nevada, Fremont found the western or Sacramento foot, five hundred feet above the sea, the eastern four thousand feet; and the whole of this "Great Basin" (excluding its mountains) from east to west ranged in altitude above the sea from four to six thousand feet. The Great Salt Lake near its Eastern limit, is 4,500 feet above the ocean, and Pyramid lake,† a beautiful body of water twenty-five miles long, near the eastern foot of the Sierra Nevada, is 4,890 feet.

This Basin is therefore a peculiar feature of the western territory. Instead of the usual western slope of the Great Rocky Range, there is here no proper descent to the westward of the Salt Lake, until crossing the Sierra Nevada. This is seen in the following profile section reduced from Fremont's.

The contrast with other parts is well shown by comparison with the sections on pages 376, 377, one along the Columbia, and the other by the river Gila.

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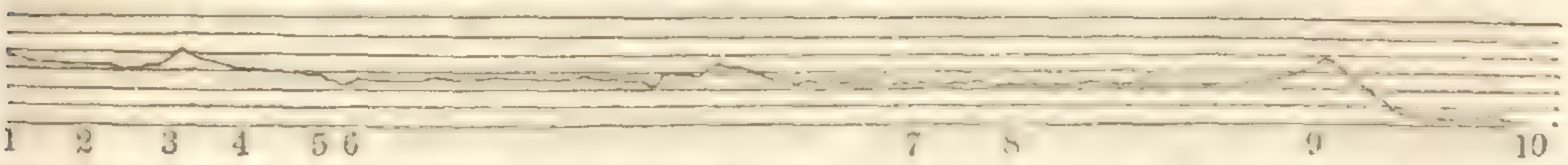
* Geog. Mem. upon Upper California. 1848.
† This Journal, ii ser., iii, 201, 1847.

The height above the sea of Wallawalla at the forks of the Columbia is but 1,286 feet.



Profile of the route from the South Pass across the Great Basin to Francisco Bay, by J. C. Fremont in 1845. Spaces between the parallel lines each 2000 feet; horizontal scale one-thirtieth the vertical. 1. South Pass. 2. Green River. 3. Bear River Mountains. 4. Beer or Soda Spring. 5. Mouth of Bear River. 6. Great Salt Lake. 7. Humboldt R. valley. 8. Humboldt Lake. 9. Sierra Nevada. 10. Francisco Bay.

Among the east and west or *transverse* ranges in this eastern section, there are the Salmon river mountains and the Spokane range in Oregon: and the northern and southern limits of the Great Basin are laid down by Fremont with the same direction.

3. The region west of the Cascade Range, or *Western Region* of the Territory, is bordered on the coast side by a mountainous region varying from a few hundred to five thousand feet in height, yet mostly below three thousand feet. It occupies a breadth of ten to fifty miles near the sea, constituting a very broken country, and in some parts consisting of two or three parallel ridges. The general direction is parallel with the coast and the Cascade Range, conforming thus to the great system of the West. A few lofty peaks to the north rise beyond the snow limit. Mt. Olympus, south of the straits of De Fuca, is a high peak, probably extinct volcanic, having an altitude as Captain Wilkes states, of 8,138 feet. Mount Fairweather, 15,000 feet high, and Mount St. Elias, 17,000 feet, near latitude 60° N., properly belong with the Coast Mountains. Swalalahos is an ancient crater, south of Astoria, and not far from 3000 feet in height. East of Francisco, Mt. Diavolo, according to Fremont, is 3,770 feet high.

The subdivision of the Coast Range into parallel ridges is well seen south of the Bay of Francisco, and it is also as decided in some parts north.

Besides the north and south ridges, there are others of a transverse course, or east and west direction. The Elk Mountains near latitude 43° 40′, the Umpqua mountains in latitude 42° 50′, and the Shasty just north of 41°, are natural boundaries, extending east and west across the western section of the territory, and dividing it into geographical districts,—the *Umpqua*, and the *Shasty*, with the *Willammet* on the north, and the *Sacramento* on the south. The Elk Mountains were crossed by the writer about thirty miles from the sea, and in this part they were 1,200 to 1,500 feet in height. The Umpqua mountains, nearly at the same distance inland, were 2,000 to 2,500 feet in height—a steep and rugged collection of ridges. The Shasty mountains, west of the Shasty Peak, were from 2,000 to 6,000 feet high,

and covered the country for a breadth of forty miles in latitude, forming thus a wide barrier between the Shasty and Sacramento regions. There is another smaller ridge between the Clammat and Shasty rivers, east of the junction of these streams, and situated near the parallel of 42°; as it lay along the southern boundary of Oregon, we called it the *Boundary Range.* It was about 1,200 feet high at our pass, and some of its peaks rose to 1,500 feet.

III. *Rivers and Valleys.*—The peculiar arrangement of the mountains parallel with the coast, gives necessarily a corresponding course to the valleys and rivers. Instead of opening on the sea, the valleys are shut off from the sea by one or more mountain ranges, and the facilities of intercourse in a north and south direction, are far greater than from west to east.* Indeed, as already stated, the long Cascade range proves an almost insurmountable barrier for merchandise, except along the passage cut through it by the Columbia: and it was with full knowledge of this difficulty, especially over northern Oregon and the territory beyond, that led Great Britain to insist so earnestly upon extending her rights south so as to share at least in the benefits of this highway.

The Columbia, just west of the Blue Mountains, near Wallawalla takes an abrupt bend and forks. The southern fork, or Lewis River, curves around the northern extremity of this range, and then follows its eastern side far to the southward and eastward. The northern fork follows a nearly north and south course (parallel with the line of direction of the Blue Mountains) for one hundred and fifty miles from the forks, then stretches east till a chain corresponding to the Blue Range is passed; then strikes north again, rising gradually towards the summits of the Rocky Mountains. Its course in this its upper part indicates still other ridges with the prevalent direction. For in latitude 49° it widely forks, and the two branches flow in opposite directions; one (Flat or Kootanie river) extending southeast parallel with Lewis river to latitude 48°, then returning nearly upon its course, and running north and south for one hundred and sixty miles near the crest of the Rocky Mountains; the other branch (the Columbia proper) stretches northerly to latitude 52°, then curves short around and after one hundred and eighty

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* The transverse ranges of Southern Oregon, separating the Willammet, Umpqua, Shasty and Sacramento districts, are an impediment in the way of an easy construction of roads (especially railroads) from north to south. The Shasty mountains particularly, (see page 253 of this volume,) are a serious obstruction. It is however possible, that by the course of the Sacramento to the east of the Shasty Peak, and then by the Clammat from its source, a feasible but circuitous route may be found: and passes through the Umpqua and Elk mountains may possibly be discovered either to the east or west of our route.

miles in its new direction, finds its source within a few miles of the head of Flat or Kootanie river. Viewing the river in its general course, we have the following lines, parallel nearly in direction with the Rocky Mountain range.

1. The headwaters of the Columbia and Kootanie, along the crest of the mountains; the two together about 350 miles.

2. The continuation of these rivers (after their reversed course) to their junction;—another 350 miles.

3. The great bend from Fort Okonagan to Fort Wallawalla; about 150 miles,—not counting the irregularities.

4. The general range of Lewis river, east of the Blue mountains.

5. A north and south portion, just west of Vancouver, 40 miles in length.

At the same time, the intermediate parts of the river have a *transverse* course.

We thus see how the long parallel mountain ranges, by acting as barriers to the waters that flow from the mountains to the sea, have compelled the river to bend north and south, with many turns and long reaches—like the track of a vessel beating against a head wind—before it terminated its course in the ocean. The whole interior for a length of 800 miles, north and south, (latitude 42° to 50°,) finds an outlet for its waters through the Cascade range, by this single channel.

The fact stated of the Columbia is a general truth for the whole western territory. A north and south course is marked in nearly all the features of the country. Between the Blue mountains and the Cascade Range, the Fall or Chutes river flows from a point 180 miles south. John Day's creek is another smaller stream a little to the east of Fall river. At the northern extremity of the great bend in the Columbia, near Okanagan, the Okanagan river empties, having flowed from the north, over 150 miles, parallel with the north branch of the Columbia, so that this river and the Columbia below its mouth together, make a continuous north and south line 300 miles long. Fraser's river farther north, has a north and south course, of 300 miles, independent of its windings.

Passing to the *Western* Section, the same peculiarity is observed. The intervals between the Cascade and Coast Ranges is a vast trough extending north and south, containing the Willammet river on the north and the Sacramento (with the Joaquin) on the south. The Willammet valley, south of the Columbia, including the region of its tributaries, covers an average breadth of sixty miles, and extends south to the Elk mountains, a distance of 140 miles. A bend in the Columbia, at the mouth of the Willammet, throws forty miles of the former river into a north and south course corresponding with that of the latter; and from the

north, the *Coulitz* enters: so that the whole Willammet depression of the surface is 200 miles long. South of the Elk mountains, the transverse ranges have given rise to small east and west streams, the Umpqua and Clammat. But beyond the Shasty mountains in that direction, we open on the magnificent valley of the Sacramento, which is one with that of the San Joaquin, the two rivers flowing in opposite directions from the extremities of the long basin, and joining their waters near its center, to flow together into Francisco Bay. The valley is 450 miles long; its alluvial country ten to sixty miles; and the tributaries embrace a breadth of sixty to one hundred. The river receives its principal head waters from the eastward through a break in the Cascade range near the Shasty peak. Just before leaving the Shasty mountains on our overland excursion, this stream was seen uniting its more copious waters with those of the tributary (Destruction river) followed down by our party.

Among the coast mountains themselves, and the minor features of the country, there is a marked correspondence to this north-and-south system. Near Astoria, Young's creek flows from the south, and is thirty miles or more long. The southern arm of the Bay of Francisco lies between ridges of the Coast range, which are two to five thousand feet high, and the same valley extends to the latitude of Monterey. Here, another shore ridge commences, and the valley of the Buenaventura, partly a continuation of the preceding, stretches on south for 150 miles. The overlapping ends of the shore ridges just north and south of Monterey are worthy of note. The Bay of San Diego has a similar parallelism with the coast in its longer diameter. The streams north of Francisco conform to the same system. The gulf of California, moreover, is nothing but a great trough between north-and-south ranges of heights, though bounded by a comparatively low country on the east.

This character of the country has a vast influence upon its agricultural resources. Not only have the waters been compelled to collect into large rivers, the most favorable for navigation, but by this arrangement they have been retained long on the land to fertilize its surface. The beds of the streams instead of having a rapid descent in these hilly regions, and in place of containing a torrent that should waste in the sea the debris of the mountains, are gentle in inclination along their lengthened course; the waters spread wide their floods, and distribute their alluvium over a large surface, giving great extent to the fertile bottom lands. The contrast is at once seen if the region of the Sacramento and Joaquin is compared with the Shasty and Umpqua districts farther north, where the rivers are small and run in rapids the greater part of their course, and their flats are contracted though including some good land.

IV. *Forest and prairie regions.*—The valleys and mountain ridges vary in their productions, appearance, and climate, according to their greater or less proximity to the sea, and the height of the land above the ocean's level.

The general character of the Sacramento plains,—their wide extent—their upper and lower prairies—the openness of the land, with only scattered oaks where there are trees at all, were subjects of remark in a former article, (p. 247.) The Willammet is a similar region. It includes extensive flat prairies—the alluvial plains of the river—lying at two levels, the upper about fifty feet above the lower. These prairies are one to fifteen miles in width, and on either side, rise into rolling grassy hills, a hundred to a thousand feet high. The whole breadth of the prairie region. including hill and plain, is said to be sixty or seventy miles. The river, winding through the prairie, lies between banks twenty to twenty-five feet high in the dry season, and is bordered by a line of trees and shrubbery. A similar border of pines and cottonwood fringes each of the tributary streamlets, and in a view from an adjoining hill, the water-courses are traced in their meanderings through the plain by these threads of forest. The open prairie is dotted with distant oaks and covered thinly with grass growing in scattered tufts eighteen to twenty inches apart. The soil is in general good, and where the hills are unfavorable for cultivation, they may afford excellent pasturage.

Such are the prominent characters of the Willammet district. Other rivers have similar prairies varying with the size of the streams. There are small plains about Champooig, just west of Willammet, near a creek and some lakes. On the Cowlitz north of the Columbia and also about the upper part of the Chikelis the prairies have much beauty. Upon the lower Columbia prairies exist near Vancouver, though not extensive; but for the greater part of the distance west, to within twenty-five miles of the sea, the banks of this river are mostly palisades of basaltic rock one to two hundred feet high; for the last twenty-five miles there is a change to tertiary sandstone and shale with only an occasional dike of basalt. In the Umpqua and Shasty or Clammat districts there are other open prairies over hill and plain, though of less extent; moreover they are not as productive, owing to the prevalence in some parts of talcose or hornblendic rocks, and of sandstone in others.*

* From the Columbia to the Umpqua, the prevailing rocks were the Astoria tertiary sandstone. But south through the Umpqua mountains, there were talcose and hornblendic rocks and a siliceous pudding-stone, producing rugged features in the landscape, and giving abrupt and broken slopes to the hills. Hornblendic rocks and granite continued to prevail south beyond the Shasty. Then (in the Clammat region) appeared sandstone and basalt again and afterwards serpentine, syenite, trachyte, granite, talcose and other rocks as explained on pages 250–257.

But in the vicinity of the sea the country instead of being open prairie is covered with forests of evergreens. In Oregon these prevail over the larger part of a breadth of thirty miles along the coast. In the vicinity of Astoria, as has been mentioned by various travellers over the region, the trees of the dense woods are extremely large—two hundred and fifty to three hundred feet being a common height. In July, 1841, on an excursion to Mt. Swalalahos, twenty-five miles south of Astoria, we travelled over a heavily timbered undulating country, passing trees occasionally twenty-five feet in circumference; and one measured was thirty-seven feet. In some places the fallen trunks of trees (pines, hemlock, spruce, and alders) so obstructed the way, that we were compelled to travel upon them, passing from one to another, seeing the ground ten to fifteen feet below us. The soil was generally good, and supported a thick growth of underbrush. There were flats near Chishuk's river, but they were covered with forests.

The country of the Western Section is thus divided longitudinally into a forest and prairie portion, the former densely wooded, the latter bearing only scattered oaks, and lines of forest along the streams. Yet in these prairie districts, elevations over one thousand feet high are wooded like the coast region, and the forests extend down their slopes, especially the northern and western, nearly or quite to their bases. Elk mountain and the Umpqua ridges were thus densely clothed with forests.

Beyond the Cascade Mountains, in the Eastern Section, even the forest-border to the rivers fails to a considerable extent, and the woods are confined to still higher ridges. And beyond the Blue Ridge, to the summits of the Rocky Mountains, there are few arable spots in a region of wide sterility.

North of the Columbia this coast region of forests widens, while to the *south* it gradually narrows. Near Francisco Bay the lower hills are mostly bare of trees, or support only grass and shrubbery. Only the ridges of the coast range, a thousand feet in altitude and higher, are well wooded, and produce the famous cedars of the region. Going farther south, the forests of the ridges are confined to those of still greater height; and in the Californian Peninsula, as travellers affirm, the mountains are bare to their summits. The region is a collection of lofty ridges, wild and rugged, overrun with rocks and sand, and mostly bare of verdure. The Cerro de la Giganta is 4,500 to 5000 feet high. Only two small streams enter the sea on the west, and none on the east. Humboldt says, where there is soil there is no water, and where water, nothing but rocks.

Thus whether we recede inland from the coast, or southward along its course, forest vegetation gradually diminishes; while going northward it increases in extent. The lower lands are

wooded about Astoria,—only the hills or mountains near Francisco,—and not even the loftier ridges in the Peninsula of California. Lines of equal forest growth—supposing the surface at a corresponding level and uniform throughout—would very slowly diverge from the coast as we follow them north in California, a little more rapidly in southern Oregon, and still more so to the north of the Columbia: such lines would curve, as we have reason to believe, with a regularly varying curvature.

Exceptions to such regular courses in these lines necessarily proceed from inequalities of surface, the varying direction of the coast, and from the moisture of springs in low lands. It is also a common fact that where hills of five to eight hundred feet are bare of trees throughout, those of twelve hundred will be wooded to their bases, owing to the moisture which these higher ridges condense to be thence carried down the slopes.

V. Climatal cause of the distribution of forest and prairie regions.—The peculiarities mentioned, run parallel with other facts relating to the climate: and the parallelism is so exact, that we cannot fail to recognize the cause of the former in the latter. A full series of meteorological observations for the territory has not yet been made. But it is sufficient for the present purpose to know that the rainy season in the Willammet (lat. 45° to 46°) continues through five to seven months, the colder months of the year; while on the lower Sacramento—about latitude 38°—it is usually confined to three or four months. The rains ceasing, the grass dries up in the course of the following one or two months, and remains as dry fodder for the cattle through the rest of the year, the juices being retained in consequence of the completeness of the drought. This was the condition of the plains when traversed by the writer in August, September and October of 1841. In Oregon in the month of August, the lofty cones of St. Helens and Mt. Hood, though piercing far into the region of perpetual snows, were unobscured to their summits—standing as natural hygrometers, indicating the dryness of the season at every height to 15,000 feet. There was occasionally a light haze in the atmosphere, but rarely a cloud. This is widely different from the condition of the much lower mountains of Eastern America. There was no rain during the journey from Vancouver to Francisco. The remarks here made apply particularly to the region between the Cascade and Coast Mountains, or *over* thirty miles from the sea.

Within the Coast region, where forests prevail, the mists of summer are frequent and extremely copious, almost or quite amounting at times to rain. On ascending the Columbia, we passed abruptly about forty miles from its mouth, from a region of dense fog, to sunshine; and looking back, the mist seemed to stand like a high barrier across the country. The same is the

character of the climate both north and south. These mists keep the country moist and sustain many small streams. There is then no mystery in the prevalence of forests about the hills, plains and mountains of the coast.

Again, the *temperature* of the coast and that of the interior portions of the Western Section (west of the Cascade Range) are widely different. In the Willammet, the summers are hot as well as dry, the temperature usually varying between 68° and 90°.* On the Sacramento the heat is much more excessive,—there is a beautiful clear sky, but a parched land beneath; and the long succession of hot days, the thermometer often up to 100° F., make it a debilitating climate for a long residence, although excellent in other respects, excepting for a time in autumn when there are intermittent fevers. The rains do not set in till November or December.

On the coast at the mouth of the Columbia, the nights are cold, and the days are hardly comfortable in summer without a fire. At San Francisco, which is near the coast, the thermometer in summer according to Mr. Lyman's observations in August, 1848, was not above 68° F.; and chilly fogs were frequent, so that fires were necessary to comfort.† A degree and a quarter farther south, at Monterey, according to observations in 1845 by Mr. Talbot H. Greene, the thermometer was not above 74° in any part of summer; in August, it ranged between 42° and 73°.

Between the two extremes, the cold shores of Francisco and the hot interior plains, lies the fertile valley of St. Joseph, forty miles from the ocean, and separated from the valley of the Joaquin by a ridge two to five thousand feet high. Here the airs are mild and pleasant throughout the season: neither the chilling mists of the coast nor the parching heat of the Sacra-

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*The following facts are derived from tables by John Ball, made in 1832 and 1833, at Vancouver, Oregon. (This Journal, xxviii, 9, 1835.) The hours of the observations are not given.

	Extremes at morning.	Extremes at noon.	Mean at noon.
Temp. of December, 1832, . .	32 and 53° F.	40 and 54	45
" January, 1833, . .	17 and 54 F.	28 and 58	41½
" February, ...	32 and 47 F.	44 and 55	48½
" March, ...	32 and 40	50 and 60	. . .
" April, ...	32 and 41	45 and 65	. . .
" May.	32 and 60	50 and 75	. . .
" June, ...	45 and 60	55 and 95	. . .
" July, ...	41 and 60	73 and 95	84½
" August, ...	46 and 63	69 and 93	77
" September, . . .	43 and 60	57 and 88	71

The observations made under the direction of Capt. Wilkes, gave for July, the mean at 2 P. M. 87°, for August 86°, for September 78°. (Narrative, v, 138.)

A full Report of the Meteorological observations of the Exploring Expedition, including those made in Oregon and California, is yet to be published by Capt. Wilkes.

† This volume, page 291.

mento and Joaquin intrude; and it is this intermediate position which gives to the region its remarkable salubrity and exuberance of fertility. The mists and rains are collected by the high ridges that bound it on the east, and at the same time a shore range cuts off the cold of the coast.

The climate of the inner portion of the Western section of the territory is farther modified by the summits covered with snows that occur along the Cascade mountains of Oregon, and that constitute the lofty Sierra Nevada. They cause cool nights to follow the hot days and ameliorate the excessive heat, especially on the plains in the vicinity of the range. Within thirty miles of the Shasty Peak, we had 90° F. in the shade at noon, and 32° F. the next morning just before sunrise; and such changes happened several times along the route.

To the eastward, beyond the Cascade Range and Sierra Nevada, the country is more elevated and colder; and the climate becomes gradually more and more dry towards the summit of the Rocky Mountains, being excessive in its drought to the south about the region of the Colorado. There are at long intervals green spots that admit of cultivation by irrigation.

Over the Great Basin, Fremont found a cool climate, though less so, for the season, notwithstanding its height, than in Eastern America. Crossing it in November, 1845, (5th to 25th), between latitudes 41° and 38°, the mean temperature at sunrise was 29°, and at sunset 40°. Excepting a snow storm between the 4th and 7th, the weather was uninterruptedly clear until the close of the year, without rain or snow. He observes also that "the winter of 1843, 1844, within the basin, was remarkable for the same open, pleasant weather, rarely interrupted by rain or snow."*

Emory, in the month of November along the Gila, had generally clear weather, with rain but twice. The temperature on Nov. 23 and 24, near the mouth of the Gila, varied from 40° to 69° F.; (40° at 6 A. M.) On the morning of the 25th, it was at 27° F.; morning of the 26th at 5 A. M. on the Jornada, 21° F., and 60° F. at 5 P. M. A desert was passed between the Rio Colorado and the mountains east of San Diego.

It has not been our purpose to present a full account of the meteorology of the region. We have cited a few facts only in illustration of the general views here presented.

The great difference between the mean temperature of the east and west coasts of America is a fact well known. Vancouver in latitude 45° 40′, has nearly the temperature of Baltimore in latitude 39° 22′, and generally, the difference corresponds to six or

* Geographical Memoir upon Upper California, p. 13.

seven degrees of latitude, being as great nearly as between the eastern and western borders of the Atlantic.

Peculiarities of climate are to be traced to the prevalent winds, the height and position of a country, and the courses and heights of its mountains. The winds from an open ocean, as has been often observed, will seldom be much colder than the temperature of the ocean itself, and this is below freezing. But winds from the land partake of the heat and cold of the land, which have a wide range. Thus in Tierra del Fuego in latitudes 52° to 55°, the temperature of winter is comparatively mild.* Again, when the winds come from over open arid land in summer, as happens at times in Eastern Australia, and often with all regions in the vicinity of deserts, there is an excessive heat in the atmosphere; or when they blow from northern territories covered with snows, as is common in winter in the northern portion of the United States, extreme cold is the necessary consequence.

In Western America the prevalent winds are from the ocean. This fact alone is a sufficient cause for the mildness of the seasons, as compared with eastern America.† But besides this, when a land breeze blows in the colder months, it comes usually from the southward and eastward and seldom from the northward or north-eastward.‡

The same facts explain the peculiar dryness of the climate in summer, and the occurrence of rains in winter. The oceanic

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* Fitzroy, who spent many months of different years about Tierra del Fuego, states that in June of 1834, (corresponding to our December,) the thermometer did not sink below 38½° F., and the mean of the first twelve days was 41° F. In February of the same year, (corresponding to our August,) at Port Famine, the thermometer ranged between 47½° and 53½°. In February of 1833, at Good Success Bay, and in that vicinity, (lats. 53 to 55,) the thermometer ranged from 46½° to 51°.

† Capt. Wilkes observes on this point, "I am disposed to believe this (the heat of summer) to be owing to the prevalence of southwesterly or ocean winds."—*Narrative*, v, 159.

‡ From the table by Mr. Ball, referred to on page 390, we obtain the following facts, relating to the prevalent winds of the months of the year.

	Westerly.	E.	S.E.	S.	N.E. and N.
November, 1832, .	13 days.	9 days.	8 days.	. .	. .
December, . .	5	. .	24	2	. .
January, 1833, .	6	13	8	1	. .
February, . .	12	1	7	5	2
March, ...	25	. .	4	2	. .
April, ...	22	. .	2	3	. .
May, ...	22	. .	4	4	. .
June, ...	24	. .	. .	1	5
July, ...	21	2	. .	. .	5
August, . . .	20	1	1	. .	4
September, . .	11 (variables 8 dys	. .	2	2	4
October, . .	15	5	9	. .	2

East winds were observed only three times during the summer the Exploring Expedition was in Oregon. The winds were almost constant from the W.N.W. to W.S.W.

winds come to a great extent from the northwest and west. Being cooler than the land of the interior, (which is heated by the sun's direct rays above the temperature of the ocean,) they are gradually becoming warmer as they range along to the southward and eastward over the territory: and as heated air will take up more moisture than cold air, the capacity for moisture is gradually increased. The winds therefore come from the ocean with comparatively little moisture, and as they become warmer in their progress, they are continually absorbing it from every surface or object they touch, and thus parch the open lands.*

Just the reverse condition exists upon the eastern shores of our continent, where the winds blow to a great extent from a tropical direction, and coming surcharged with moisture, drop it readily against the cold hills, or wherever northerly airs are encountered.

About the hills and ridges of the interior, much moisture is condensed. For besides dews, mists form in these more elevated regions in *three* ways:—(1) either from the cooling of a moist overlying atmosphere below the dew point through the influence of the cooled land and foliage;—or by means of the winds that blow over the hills, which may either (2) condense by their coolness the moisture of the air about the heights, or (3) bring in moisture to be condensed by the cool hill-sides;—the results depending somewhat upon the time of the day and the season of the year. These regions are thus enabled to support a growth of trees, when the plains below are bare.

Along the shores, the ocean winds produce comparatively cool weather in summer, as they have not been moderated in temperature by passing over any part of the land. Within thirty miles of the sea, the lower airs that oscillate back and forth, as night and day alternate, are usually moist and favor the formation of heavy mists. The land chilled at night by winds and radiation, often chills the air above, so as to cause the moisture to become visible in mists. In the formation of these mists in other cases, the sea-breeze encounters a cold land and cold airs, and its vapors are thereby condensed; or it meets with warmer moist airs and condenses the moisture they contain. By these means, at different periods, a moist climate is produced.

Southeast and south winds usually bring clouds and rain over Western America, and these are common in the winter months. They are warm winds charged with moisture which is readily

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* Mr. W. C. Redfield first applied this principle in explaining the origin of deserts; and as he has shown, it is not only sufficient, but the only one sustained by facts. For it meets the important general truth that deserts occur within the latitudes 20° to 35° north or south, and principally on the *western* side of continents, where the winds are blowing for the greater part of the year from extra-tropical latitudes, towards the tropical, and are therefore drying winds.

yielded as rain, on encountering the colder airs and colder country reached in their progress north.

The Westerly winds alluded to are well known to pertain to the great circuits of the atmospheric currents. As the trades (easterly winds) prevail over a large part of tropical latitudes, below the parallel of 25° or 30°, so westerly winds prevail in extratropical latitudes north and south of latitude 30° or 35°.* These winds are even more regular and constant in the Pacific than in the Atlantic,—both north and south of the equator; and vessels are accustomed to take advantage of them in their voyages across the ocean.

From the survey of facts which has been made, it is apparent that the prevalence of oceanic westerly winds in connection with the infrequency of northern land breezes, is the cause of the mildness, as well as dryness of the climate of Northwestern America. It has determined the distribution and limits of the forest and prairie regions, and has originated the barren semi-deserts of inner and lower California. The great Dividing Mountains of the Territory (the Cascade Range and its Southern continuation) prove a partial barrier to these ocean winds, preventing them more or less from carrying their moisture easterly and scattering too widely the scanty allowance to benefit essentially the country; they gather the vapors partly in solid snows about their heights, and partly in mists and rains, thence to impart waters to streams that flow down and irrigate the wide valleys. A region along the Pacific is thus cut off from the arid interior and rendered fertile; and its salubrity is farther enhanced by the cool airs from the mountains poured at night upon the heated plains. The long parallelism of the mountain ranges to the coast, has given great length to the rivers by forcing the waters over a large area into a few main streams that make a long and devious way to the sea, expanding thus the alluvial prairies and distributing channels of internal navigation. By such means, the Western section of the Territory is made to abound in agricultural and pastoral resources, and is supplied with extensive forests, while the region east of the Dividing Mountains is comparatively unproductive. The former may become densely populated and full of activity in all the varied pursuits of civilized life; the latter promises a support only for widely scattered herdsmen, with here and there a village or town where a large stream gives sufficient water for irrigation.

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* Mr. Wm. C. Redfield, to whom we have already referred, has given us the best exposition of this subject in his memoirs. See this Journal, xx, 50, 1831; xxv, 124, 1834; xxviii, 314, 1835; xxxiii, 61, 1838; xlv, 295, 302, 1843.

ART. XXXV.—*On Biogen, or the so-called Albumen in the Ovarian Egg.* (From a letter of E. DESOR, to Prof. C. VOGT, in Giessen. Communicated by the author for this Journal.)

LIKE many embryologists I have often had doubts concerning the real nature of the so-called albumen in the eggs of the invertebrate animals. The theory of von Baer, that in animals without oviducts, the albumen is formed in the ovary itself, did not satisfy me, from what I had seen of the metamorphoses of the immature egg. And having an opportunity during the past winter to examine a great number of invertebrate animals, I took the occasion to investigate more closely this supposed albumen.

The following facts in their general outline were observed in the eggs of various animals, particularly Mollusks and Worms, but most thoroughly in the ovarian eggs of Ascidiæ.

On the 15th of May of this year, I first had the opportunity of examining the ovary of *Ascidia rustica* from Boston harbor. I extracted the ovary of a full-grown animal, and on bringing it under the microscope, I found it filled with vesicles of very various size and appearance; some very small and transparent; others somewhat larger, with granular contents; and others again, the largest of all, having in the middle an opaque ball surrounded by a transparent liquid. With a stronger magnifying power (100 diameters) I discovered yet smaller eggs looking not larger than a pin's head, and measuring less than $\frac{1}{150}$ of a millimetre, (fig. 1.) whilst others had the apparent size of a pigeon's egg. (fig. 9.) Between these extremes I found all intermediate sizes, as shown in the following drawings, figures 1 to 9, and satisfied myself that they were all eggs. The smallest consisted apparently of a simple vesicle, (fig. 1.) In somewhat larger ones, two outlines were visible, an outer one, the vitelline membrane, and an inner, the germinative vesicle. Within this I saw besides a smaller vesicle, the germinative dot, (fig. 2.)

As usual, the germinative vesicle in the smallest egg is very large in comparison with the enclosing membrane (the vitelline membrane.) By degrees the latter enlarges, whilst the former seems to remain stationary.

Before the ovulum has increased to double the size of the germinative vesicle, it is perfectly transparent, (fig. 1–3.) In the egg of fig. 4, the liquid began to be somewhat turbid, and the germinative vesicle seemed as if surrounded by a light cloud. In somewhat larger eggs (fig. 5,) I found the cloud more distinct, particularly about the germinative vesicle: and with an increased power (500 diameters) I could already distinguish very minute granules in it. In the egg of fig. 6, these granules were distinct

vesicles. The whole sphere, except the germinative vesicle, was filled with them. In that of fig. 7, I found the yolk-granules or

Ovarian eggs of the Ascidia rustica, magnified 160 times.*

vesicles much crowded, particularly in the middle, so that it was with difficulty that I could distinguish the outlines of the germinative vesicle. The granules had not only increased in number, but it was also evident that a condensation had taken place in them towards the middle, for it was only towards the edge that the mass appeared loose. In the egg of fig. 8, the condensation had proceeded further. The germinative vesicle was no longer visible, except when I compressed the egg. On the other hand the vitelline mass seemed to withdraw itself more and more from the edges, and already a wide border had appeared between the outer membrane and the edge of the yolk. Finally I observed in the ovary, several eggs of considerable size (fig. 9,) in which the yolk formed a compact ball, well defined on all sides, and surrounded by the transparent liquid as by an albumen, precisely as it is in the eggs after they are laid.†

From these observations it clearly appears, that this clear liquid surrounding the yolk is quite different from the albumen of the eggs of higher animals. Far from being added from without, it seems to me on the contrary to be the fundamental substance, the mother-liquid, from which the yolk is, as it were, precipitated. I

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* Fig. 1. Very small egg in which no germinative dot could be seen, but only the germinative vesicle.

Fig. 2. A somewhat larger egg, with a small germinative dot.

Fig. 3. A still larger egg, but yet entirely transparent.

Fig. 4. A light cloud is seen surrounding the germinative vesicle.

Fig. 5. The cloud has spread and is more distinct, with a granular appearance.

Fig. 6. The cloud fills the whole egg and appears distinctly as granular yolk substance.

Fig. 7. The granular yolk substance is denser around the germinative vesicle.

Fig. 8. The granular yolk substance begins to recede from the margin. The germinative vesicle has become quite indistinct.

Fig. 9. The yolk substance is condensed into a regular ball surrounded by a transparent liquid, (the biogen.) The germinative vesicle is hid[den].

† Occasionally no formation of yolk takes place, and such eggs have been erroneously considered as empty shells. The biogen is present in these also, only unproductive. These eggs (the supposed empty shells) occur particularly in the extremities of the strings of eggs in Eolis, Doris, Acteon, &c.

shall therefore designate it by another name, and propose to call it from its physiological significance, *Biogen*, or the biogen liquid.

Now if the yolk is really the product of the biogen liquid, this explains the absence of a separate covering or membrane around it. Just as in the ovarian egg of the hen or the frog, so in the ovarian egg of the Ascidia and of all Mollusks, there is but one membrane. The second, or shell membrane, is not acquired in these higher animals before the passage of the egg through the oviduct. But as nothing of the kind takes place in Mollusks, it is natural that their eggs, even *after their expulsion from the ovary*, should have only a single membrane. It is only because the transformation of the immature into the mature egg was overlooked, that the error has been committed of considering the outer membrane of fig. 9, as different from that of figs. 6 and 7. In fact however, there is no difference between them except that in fig. 9, the yolk-substance has retreated from the edges and been concentrated into a compact ball. The biogen fluid itself undergoes essential modifications in the course of the development. At first it is tolerably compact, and in many ovarian eggs even gelatinous. By degrees it becomes thinner and at last quite fluid, so that it seems to afford no important hindrance to the revolving embryo.

How far this mode of formation of the yolk out of the biogen liquid is applicable to the eggs of vertebrate animals, must be learned from future observations. Something of the kind is certainly to be seen in the eggs of Mammalia. According to Bischoff's investigations, the yolk in the mature egg of the rabbit fills the whole zone. Some days later, however, after it has left the ovary, there appears between the zone and the yolk a clear space, filled with a transparent fluid.* This fluid, to which Bischoff particularly calls attention, has, we believe, never been satisfactorily explained. For it is hardly to be supposed that it is water, received by means of endosmosis, as has been supposed in the case of the eggs of fishes; for, from whence should the water come? But on the supposition that the yolk condenses, the matter is quite simple. The clear fluid is in that case nothing else than a part of the biogen liquid, which has been separated by the condensation of the yolk.

If this explanation is well founded, there must be a time when the mammalian egg also is transparent, that is, before the separation of the yolk-granules or vesicles has begun. And indeed I should not be astonished if the vesicles with inner cells, which Bischoff figures and describes as probably immature eggs, should prove to be the analogue of our Ascidian eggs, as represented in figs. 1–5.

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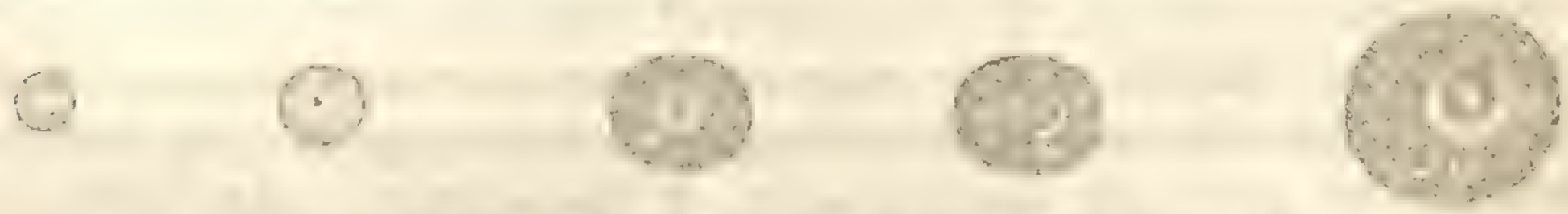
* Bischoff, Das Kaninchen-Ei. Tab. I.

As to the relation of the biogen liquid to the germinative vesicle, and which of them first appears, I could not satisfy myself neither in the eggs of Ascidia nor in those of the other Mollusks and Worms which I have hitherto examined. Although in some instances I thought I had found an ovulum consisting of a simple cell, yet on examination with a higher power, I commonly detected the enclosed germinative vesicle. My friend, Professor Gilman of New York, who has made extensive investigations of the ovarian egg of fishes, maintains on the contrary, that in the ovarian egg of the perch, the outer (yolk) membrane appears first, and that even the separation of the yolk, under the form of a slight cloud, *precedes* the formation of the germinative vesicle.*

It is doubtful therefore, whether a law is discoverable which shall be applicable in this respect to the whole animal kingdom. Meanwhile the following facts observed in a marine Worm, (Sigalion,) may not be without interest.

Last spring I had several times an opportunity of examining ovarian eggs of the Sigalion. I found them, as usual in Annelids, collected on each side of the intestinal canal. The eggs were nearly mature, and the yolk opaque. But I was struck by a reddish spot in each egg, except the very smallest; (figs. 10–14; the

10. 11. 12. 13. 14.



Ovarian eggs of the Sigalion, magnified 40 times.†

red spot is here distinguished by lined shading). What was my astonishment on bringing them under the compressorium, to see that this red spot was enclosed in a transparent vesicle: in other words, that it was the germinative dot (*vesicula Wagneri*)! Besides this, I observed that in many eggs, particularly the larger ones, the red germinative dot itself enclosed a clear transparent vesicle, as I had seen it in the eggs of Actinia, and as Valentin has observed it in the ovarian egg of the Echini, and which I for that reason propose to call *Vesicula Valentini*.

Whatever may be the office assigned to each of these parts of the egg, thus much clearly follows from this observation, that from the beginning there must be a definite and essential distinction in their composition. And it seems to me that this decided

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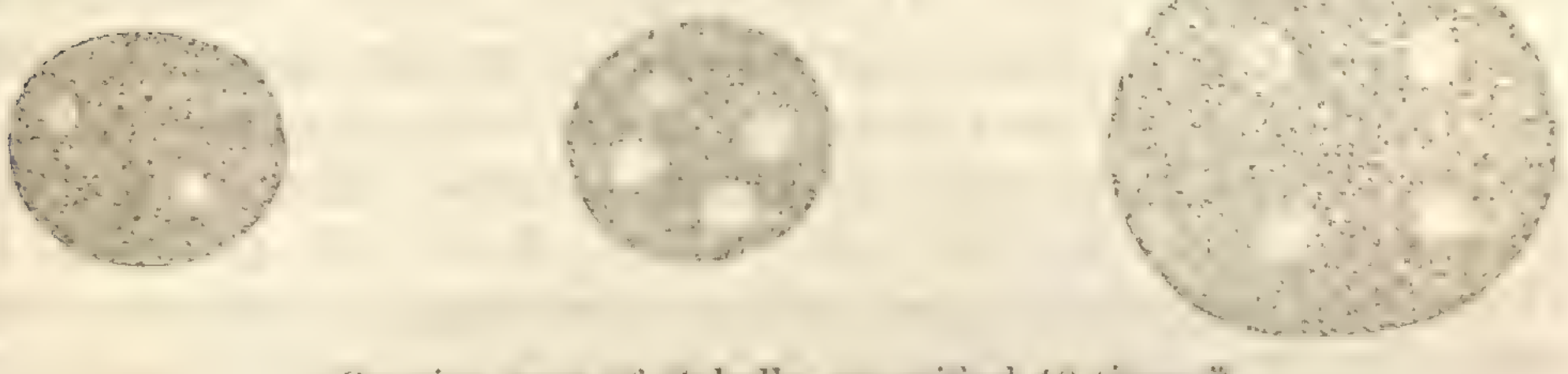
* He also maintains the existence of a double covering in the egg of fishes,—a yolk-membrane and a shell-membrane, neither of them destitute of structure.

† Fig. 10. A very small egg without germinative dot.
Fig. 11. The red germinative dot appears.
Fig. 12. The red germinative dot has grown larger.
Fig. 13. There is seen in the germinative dot a small clear cell, (Vesicula Valentini.)
Fig. 14. The vesicula Valentini is very distinct.

distinction contradicts the supposition that the so-called clear spots which so generally appear in the yolk in almost all animals, particularly at the commencement of the fissuration, are merely the remains of the germinative vesicle. Still less can they be traced to the germinative dot, since it is well known that they are always clear and transparent, and as far as I know, no one has found red spots in the spheres produced by fissuration.

This supposition, that the clear spots are derived from the remains of the germinative vesicle, is moreover opposed by the following fact, which was observed by me and several of my friends in Boston, in the ovarian eggs of Sabella, viz. that the clear spots *appear before the disappearance of the germinative vesicle*, as is seen in figs. 15–17. The spots were very distinct,

15. 16. 17.



Ovarian eggs of Sabella, magnified 40 times.*

and had the characteristic oily appearance which has induced several observers to designate them by the name of *oil-drops*. In one ovulum we saw no less than three such spots, besides the germinative vesicle. (fig. 16.) With a higher power and a slight pressure they kept their relative positions, and a careful comparison of their outlines with that of the germinative vesicle, convinced me that they were not surrounded by a membrane.

ART. XXXVI.—*On some principles to be considered in Chemical Classifications;* by T. S. HUNT, Chemist to the Geological Survey of Canada.

Read before the American Association for the Promotion of Science, at the annual meeting, held at Philadelphia, Sept. 20th, 1848.

THE progress of chemical investigation has made known a vast number of substances under the different names of "products of substitution," copulates, ethers and amids, which may be generally described as formed by the combination of two other compounds and the elimination of water or hydrochloric acid. In

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* Fig. 15. Egg showing the germinative vesicle and one clear spot.
Fig. 16. Egg showing the germinative vesicle and three clear spots.
Fig. 17. The same egg compressed.

searching for some principle which shall enable us to arrange this large class of products, the first question to be settled is, to which of the parent bodies does their type pertain? For example, is an ether to be regarded as a species derived from the acid or the alcohol, by the mutual action of which it is formed? A correct answer to this question is necessary before we can arrive at a right understanding of the laws of combination, and the principles upon which these compound, are to be classified.

The ingenious but partial views of the two great schools of the day, those of Liebig on the one hand, and those of Gerhardt and Laurent on the other, have failed to give a satisfactory answer, or to remove the many difficulties that environ the subject. There seems to be a portion of truth in both systems which each is unwilling to concede to the other. The two systems may be best compared by an examination of some well known compounds. Oxalic acid ($C_2 H_2 O_4$) which is bibasic, yields by its action upon one equivalent of alcohol ($C_2 H_6 O$), the oxalovinic acid $C_4 H_6 O_4$, which equals $(C_2 H_2 O_4 + C_2 H_6 O) - H_2 O$; while with two equivalents of alcohol, oxalic ether $C_6 H_{10} O_4$ is formed, which is equal to $(C_2 H_2 O_4 + 2C_2 H_6 O) - 2H_2 O$. These two compounds are distinguished from several isomeric bodies by the results of their decomposition; in the presence of alkalies they can resume the elements of water and regenerate alcohol and an oxalate;—a reaction which shows that in these bodies, there is a constitutional or functional relation to oxalic acid and alcohol.

It now becomes desirable to define the nature of that relation so that it may be represented by formulas. Mr. Gerhardt, keeping in view the electro-chemical ideas of Berzelius, supposes the acid to act upon the alcohol or rather upon its hydrogen by virtue of its oxygen, so that the various acids in relation to alcohols, ammonia and hydrocarbons, may be regarded as electro-negative, while the latter are electro-positive.* According to this hypothesis, in the formation of oxalovinic acid, where $H_2 O$ has been eliminated, the acid has lost O while the alcohol has lost H_2, so that the compound is to be regarded as an alcohol in which oxalic acid *minus* O replaces H_2; or rather making the electro-negative the generic type, oxalic acid where alcohol minus H_2 replaces oxygen. In the same manner, oxalic ether is the acid in which a second equivalent of oxygen is replaced by the same elements. Representing $C_2 H_6 O - H_2$ by Et:—

Oxalovinic acid $= C_2 H_2 (O_3 Et)$
Oxalic ether $= C_2 H_2 (O_2 Et_2)$

* Précis, tom. ii, p. 495.

The same view is extended to the two oxalic amids, which are the acid in which one and two equivalents of oxygen are replaced by the residue $NH_3 - H_2$ represented by *Am*, which is the equivalent of O; in the anilides $C_6 H_7 N - H_2 = An$, has the same power. A difficulty however, arises in extending this view of the constitution of ethers, for we find acids which contain no oxygen and yet act with alcohol in the same manner as an oxacid. Hydrochloric acid, Cl H, forms with alcohol, an ether with the elimination of an atom of water, precisely as acetic or nitric monobasic oxygen acids, would do. Here the electro-negative theory, as just interpreted, is at fault, and hydrochloric ether although resembling in all respects the ethers of the oxygen acids is separated from the class and made a chlorinized species of the carbo-hydrogen acetene $C_2 H_6$.

M. Gerhardt has extended this idea to all the copulate bodies derived from the action of nitric and sulphuric acids upon hydrocarbons, organic acids and neutral bodies, and in expressing by formulas their composition, admits that $SH_2 O_4 - O = Su$ and $NH O_3 - O_2 = Ni$, are to be considered as equivalent to H_2, while $C_2 H_6 O - H_2 = Et$, $NH_3 - H_2 = Am$, and $C_6 H_6 - H_2 = Bz$, are equivalent to O.

At the same time he announces the following law as regulating the basic power of all these copulate compounds, "the basicity or capacity of saturation in a coupled body is always less by unity than the sum of the basicities of the two bodies thus united." Expressing by S the basic capacity of the coupled body, and by Σ the sum of the basicities of its components, we have $S = \Sigma - 1$.*

M. Liebig on the other hand has seen the realization of the electro-chemical theory of Berzelius, in the saline constitution, which agreeably to the dualistic notions of the day, includes the idea of a base and an acid or a halogen body and a metal, (the two being united in Liebig's new theory of salt-radicals.) He sees in the ethers, compounds analogous to the salts, and in the elements of alcohol *minus* HO, something which in its chemical relations, is similar to a metal and like it is capable of replacing the equivalent of hydrogen upon which the basic power of acids depends. Some of his School, however, still clinging to the idea which recognizes combined water in the acids, choose to represent the ethers as compounds of the so-called anhydrous acids with the oxyd of the quasi-metal, but this view is still reducible to the principle which is more easily expressed in accordance with the salt radical theory. When nitric acid $NH O_3$ acts upon alcohol, the elements of an equivalent of water are set free, and nitric ether $C_2 H_5 NO_3$ is formed, which is regarded as nitric acid in which

* Précis de Chemie Organique, tom. i, p. 102.

$C_2 H_5$ ($C_4 H_5$ in his notation) = Ae replaces H; nitrate of ethyle N Ae O_3 corresponding to nitrate of silver N Ag O_3. Hydrochloric ether and the compounds allied to it, may by this hypothesis be brought into the same class and assigned the place to which by their reactions they are justly entitled; they become chlorid, bromid and iodid of ethyle.

This view removes a difficulty unexplained by the theory of Gerhardt; the ethers proper are quite neutral, the saline capacity of the acid having been satisfied by combination with the elements of alcohol. It is not easy to understand how a replacement of an equivalent of the oxygen by the organic elements, could effect this, for in many instances the oxygen of a compound may be wholly or in part replaced by sulphur or other elements without affecting its basic relations; but on this view the hydrogen of the acid, upon which its capacity of saturation depends, is removed in the elimination of the equivalent of water. Bibasic acids like the oxalic should then yield monobasic compounds with *one*, and neutral compounds with *two*, equivalents of alcohol; in accordance with this, the oxalovinic acid is monobasic, and the oxalic ethers neutral.

The amids are derived from ammoniacal salts which contain the elements of the acids *plus* NH_3, and the composition of the amid of a monobasic acid is that of the ammonia salt, *minus* $H_2 O$. Acetic acid being $C_2 H_4 O_2$ and acetate of ammonia $C_2 H_7 NO_2$ ($=C_2 (H_3 NH_4)) O_2$, acetamid will be $C_2 H_5 NO$; this compound is capable of regenerating ammonia and the acid, by assimilating $H_2 O$; it is neutral, and in its reactions so much allied to an ether that the resemblance is at once apparent; while it is equally clear that it should be referred to the acetic type. But when the acid reacts with the elimination of an atom of water, upon a body which contains no oxygen, the equivalent of this element must evidently be derived from the acid itself, and hence we cannot by any ordinary formula represent acetamid as a direct derivation of the acid; for while if we make

acetic acid, = acetic ether

$C_2 H_3 H' O_2 = C_4 H_8 O_2$

$H' = C_2 H_5$

we find that if

acetic acid = acetamid

$C_2 H_3 H' O_2 = C_2 H_5 N O$

$H' = H_2 N - O.$

In other words, if we would assimilate the amids to the ethers upon M. Liebig's plan, we must have $H_2 N - O$, replacing the equivalent of hydrogen or ethyle. He, however, disregarding the analogies between them, is obliged in accordance with his views of organic radicals to regard this and similar compounds as

containing certain hypothetical bodies, which differ from the acids by the elements HO combined with amidogen NH_2; thus benzamid is the amidid of benzoyle and acetamid will be the amidid of the deutoxyd of acetyle, which is only assimilated to acetic acid through the imaginary radical acetyle.

M. Dumas has recently observed that acetate of ammonia by the action of anhydrous phosphoric acid, loses the elements of two atoms of water and yields a new compound which has been called acetonitrile, and which may be directly derived from acetamid by the loss of H_2O; its formula is consequently C_2H_3N. The subsequent researches of Dumas, Malaguti and Schlieper, and the previous ones of Fehling. have shown that a large number of acids yield compounds similar to acetonitrile. These bodies which have received the generic appellation of nitriles, like the corresponding amids, regenerate ammonia and the parent acid by the action of alkalies and acids. If in accordance with this reaction, we attempt to refer acetonitrile to acetic acid, we have $H'=N-O_2$; or if we adopt M. Liebig's view, it is a nitruret of acetyle; and while according to M. Gerhardt, acetamid may be represented as acetic acid in which NH replaces O, in acetonitrile the equivalent of O_2 is N – H. The author of the *Précis* hence regards this and similar compounds as amids of the anhydrids of the acids and designates them *anhydrid amids*.

M. Fehling in studying the action of potassium upon succinic ether, has made known an anhydrid ether, comparable with the anhydrid amids. His alcosuccinal ($C_8H_8O_3$) is succino-vinic acid minus H_2O, and contains the elements of succinic acid and one equivalent of alcohol *minus* $2H_2O$. It will probably be a monobasic acid, since succinidam, the corresponding amid, which is the anhydrid of succinamic (homologue of oxamic) acid, is capable of exchanging an equivalent of its water for lead or barium. It is impossible, according to either of the received hypotheses, to represent this as an ether of succinic acid; agreeably to the received views it must be regarded as the ether of succinid, a substance which exhibits none of the characters of an acid.

The theory of M. Liebig which explains so satisfactorily the formation of ordinary ethers, is no longer eligible when applied to the amids; in fact the formation of ammoniacal salts by the action of acids upon the hypothetical oxyd of ammonium, is the only reaction which in his view can be regarded as a parallel to the formation of ethers. At the same time the existence of such bodies as the amethanes of Dumas, which by the assimilation of two equivalents of water are converted into a bibasic acid with one equivalent of ammonia and one of alcohol, besides the analogies already noticed, point out too plainly to be mistaken, a relation between ethers and amids which his system does not express. We are obliged to admit that as one is directly derived from alcohol and an acid, by the abstraction of H_2O, the other contains

ammonia and the acid *minus* the same elements; and if we would be consistent with the view which makes C_2H_5 (C_4H_5 Liebig), and NH_4, radicals equivalent to H, we must equally admit H_2N-O and C_2H_5-O to the same rank, for they are as really equivalents of H the atom of hydrogen.

Thus do the compound radicals come to be mere mathematical expressions; the only value which can ever be attached to them is that which belongs to an irreducible expression in an algebraic formula. Understood in this way as representing the equivalent of certain other elements, they may be conveniently introduced in our chemical formulas. Herein lies the truth of M. Liebig's celebrated hypothesis; had he seen the necessity of such substitutes for O as $\frac{N-H}{2}$ at the same time with NH_2, he would have never given the latter a rank which could imply its existence even in combination. Although the elements which in an ammoniacal salt replace H, are represented by NH_4, there is no more reason for supposing a separate existence to the elements denoted by the expression than to the kindred formulas NH_2-O and $N-O_2$, for the conception of the one violating, as it does, the laws of molecular constitution, is no less monstrous than the other.

To represent then, the *etherids* and *amids* of oxalic acid, in accordance with the compound radical theory, we have

1. Oxalic acid,	$C_2(H_2)O_4$.
2. Oxalovinic acid,	$C_2(H(C_2H_5))O_4$.
3. Oxalic ether,	$C_2(C_2H_5)_2O_4$.
4. Oxamic acid,	$C_2(H(NH_2-O)O_4$.
5. Oxamid,	$C_2(NH_2-O)_2O_4$.
6. Oxamethane,	$C_2((C_2H_5)(NH_2-O))O_4$.

The introduction of Liebig's system seems to have been almost a necessary event in the progress of chemical philosophy; it was a view which, as discovery advanced, very naturally presented itself to minds impressed with the notion of dualism, inculcated as one of the first principles of the science. A saline substance is regarded as a binary combination of an oxyd and an acid, or a metal and a radical, in which these two actually exist as such, and the analogies between compounds, like chlorid of potassium and salammoniac, are such that if we regard one as a binary combination of Na with Cl, the other must be viewed as formed by the union of NH_4 with Cl. It has however been shown that the elements thus replacing hydrogen or a metal, have not only not a necessary, but sometimes not even a possible, existence, and that all we can infer from such substitutions, is that those expressions represent an equivalent amount of the forces which are necessary to preserve the integrity of the complex molecule. Chlorine, as known to us, does not exist in common salt, for from the combining volume of the gas, it appears that in

its free state it is a combination of two atoms, and is really Cl_2; the same view extends to the metals.

It has been shown that the hypothesis of M. Gerhardt, which supposes that in ethers and amids, alcohol and ammonia *minus* H_2, replace an equivalent of oxygen, is objectionable because it does not account for the changes in the basic relations of the acids, and leaves unexplained the reason of his law of $S = x - 1$. We are thus led to recognize the view of Liebig, *apart from his ideas of dualism, and his theory of compound radicals*, as the one fundamentally true, and it remains to give it a general expression which shall include all the reactions of the class which we are now reviewing. This, we shall endeavor to show, may be accomplished by an application of the great principles which M. Gerhardt has defined in his Prècis, although still misled by the electro-chemical philosophy, he seems to have erred in their application.

The class of compounds which we are considering in the present essay, may be viewed as products formed by an apomorphosis which generally consists in the separation of the elements of water; and this class will be found to include the greater part of all chemical compounds. M. Gerhardt observes that, "*of* 1,000 reactions taken at hazard, 990 of them will consist in the elimination of some substance from the organic matters, and this something is always water, hydrochloric acid, or some other mineral substance with a composition equally simple."*

In these reactions the saline capacity of one of the bodies is always wholly or in part neutralized; in the ethers by the replacement of the hydrogen by $C_2 H_5$, and in the amids by the substitution of $NH_2 - O$ for that element. These, as M. Gerhardt remarks, are related to the ammoniacal salts, in which NH_3 replaces H, as anhydrids are to acids; the process may proceed still farther under the influence of heat or a dehydrating agent, and the monobasic salt eliminate a second equivalent of water, forming a nitrile. This is due to a farther reaction between the acid and the replacing elements, resulting like the previous one, in the separation of $H_2 O$, and a more intimate union than before, and is analogous to the change effected by heat upon tartar emetic and similar salts. These compounds, like simple anhydrids, must all be regarded as pertaining to the acid from which they are derived, and we are hence led to the enunciation of the following principle which applies to all coupled bodies whatsoever.

In all compounds produced by a reaction which results in the elimination of one or more equivalents of water or hydrochloric acid, (or any body referable to the type $H_2 O$ or H_2,) the parent body is that which loses saline hydrogen.

(To be continued.)

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* Précis, tom. ii, p. 495.

Art. XXXVII.—*New and Rare Plants, chiefly of the Carolinas;* by M. A. Curtis.

Malva triangulata, *Leavenworth.*—M. Houghtonii, *Torr. & Gray!* This species was detected some years since on the Catawba in Lincoln Co., N. Car., and sent to me by Dr. C. L. Hunter.

Ptelea mollis, *n. sp.*—P. trifoliata, *β.* mollis, *Torr. & Gray?* I. 680. Lateral leaflets oval, the terminal obovate, with an abrupt acute point, the underside with the petioles, panicles and young branches, clothed with a soft whitish silky villus; cymes compact, with short branches; style long; filaments equalling the anthers.—Wilmington, N. Car. Also, Newbern, N. C.; *George Wilson, Esq.:* the low country of S. Car.; *Rev. T. J. Young.*

The style in this species is twice as long as in P. trifoliata, while the filaments are only about one third or one fourth as long. The mature leaves are much more rigid. With the exception of the style, this plant is much smaller in all its parts, and the sepals very deciduous. Flowers tetrandrous.

Galactia sessiliflora, *Torr. & Gray!*—This species extends along the interior portion of the sandy region of S. Car., to Cumberland Co. in N. Carolina.

Petalostemon corymbosum, *Michx.* var. *β.*—Folioles 5–7 pairs narrowly oblong linear, commonly emarginate. A very marked variety. Low country of S. Car.; *Rev. T. J. Young.*

Baptisia Serenae, *n. sp.*—Very smooth, branching; leaves oblong-obovate, cuneate, petioled; flowers (yellow) in a long loose central raceme and in short racemes terminating the branches; pedicels longer than the calyx in fruit; segments of the calyx villous on the inside; legume oblong inflated, the stipe longer than the calyx. Society Hill, S. Car. Flowers May, June.

Diffusely branched, 1–2 feet high, partaking somewhat of the habit of both B. alba and B. tinctoria, its period of flowering being between theirs. It differs from the latter in the characters given above and in not turning black in drying:—from B. Lecontei in its smoothness, the absence of persistent bracts, the shape of the legume, &c. Folioles about an inch long,—legume, without the stipe, about 8 lines.

Alchemilla arvensis, *Scop.*—Common on grass-plats along the Pamlico in Beaufort Co., and around Oxford, N. Car. Evidently introduced.

Diervilla sessilifolia, *Buckley!*—Yenah Mt., Georgia. *H. W. Ravenel.*

Liatris pilosa, *Willd.* (Torr. & Gray!)—Henderson Co., N. Car.

L. PAUCIFLORA, *Pursh.*—I have no doubt that this is a branched state of L. secunda, probably caused by some injury to the summit of the stem. The allied species are not unfrequently met with in a similar condition. There is no essential difference in the descriptions of L. secunda and pauciflora, if we exclude the pseudo-paniculate character of the latter.

COREOPSIS DISCOIDEA, *Torr. & Gray.*—Not uncommon in the low country of N. and S. Carolina.

BALDWINIA UNIFLORA, *Nutt.*, β PURPUREA.—Disc flowers and summits of the interior scales of the involucre dark purple. Stem 2–2½ feet high; lower leaves 3–4 inches long, with a long tapering base. Flowers 1½–2 inches in diameter.—Springy ground near Society Hill, S. Car. Sept.

MARSHALLIA LANCEOLATA, *Pursh.* β PLATYPHYLLA.—Radical leaves broadly spatulate or oblanceolate, those of the stem becoming oblong, lanceolate, or lance-oblong, amplexicaul. Radical leaves 5–6 inches in length, with long slender bases, the cauline with gradually shorter bases, the upper sessile. Stem leafy to near half its height. This form has a strong resemblance to M. latifolia.—Middle country of N. Carolina. I have collected a very similar form, but with narrower leaves, near Augusta, Georgia.

PHYSALIS MARITIMA, *n. sp.*—Softly villous and generally hoary, erect or decumbent, dichotomous. Leaves oval-oblong or oval, entire, petioled, often in pairs, acute at base, the summit obtuse. Flowers (yellow) on slender nodding pedicels. Fruiting calyx inflated, large, ovate, smoothish, enclosing the berry.—Sandy sea-shore of N. Car., and occasionally a few miles in the interior. Pedicels an inch long, equalling the petioles. Flowers through the summer. This can hardly be P. pubescens, *Pursh*, to which Gray & Engelmann have doubtfully referred it in PLANTAE LINDHEIMERIANAE.

ASCLEPIAS ACERATOIDES, *n. sp.*—Stem low, erect, tementose pubescent; leaves coarse and rather rigid, opposite, short petioled, mucronate, somewhat whitish tomentose when young especially beneath, acute at base, oval, oblong, and elliptic-oblong, obtuse or with a short acumination. Umbels numerous, sublateral, subsessile, loosely few flowered. Pedicels long, (1 inch,) pubescent. Flowers large and greenish. Calyx segments linear-lanceolate, pubescent, nearly half the length of the corol. Divisions of the corol ovate, obtuse, pubescent, longer than the crown. Hoods equalling the gynostegium, obliquely truncate outwards, the points obtuse; horn adnate to the hood to its summit, triangular falcate, compressed, slightly exsert, and, like the interior of the hood, minutely pubescent.

Three to twelve inches high, beginning to blossom at a small height. Umbels at first sessile, then sometimes acquiring a short

peduncle, alternating on different sides of the stem from the second or third pair of leaves to the summit. Follicle ——?— Sandy pine woods of Cumberland Co., N. Car., west of the Cape Fear; also, Society Hill, S. C., where it was detected by my young friend, *Miss Serena Williams*. Flowers May, June. Has very much the aspect of Acerates, and, like A. viridiflora, varies exceedingly in the form of the leaves.

Fraxinus platycarpa, *Michx*. β. pubescens.—Young branches, petioles and underside of folioles, softly tomentose.

F. platycarpa, *Michx*. γ. oblanceolata.—Glabrous. Samaras oblanceolate.—For these two forms of F. platycarpa I am indebted to my generous correspondent, Mr. Ravenel, who sent them from the region of the Santee Canal. The species can hardly be confounded with any other, though apparently subject, as are probably the other species, to considerable variation. These varieties, like the more common form, frequently have the samaras three winged. The calycle is not noticed by Michaux either in his description or figure, but it is as conspicuous as in any other of our species.

Quercus Georgiana, *n. sp.*—Dwarf. Leaves small, petioled, very smooth, somewhat obovate in outline, cuneate and often unequal at base, 3- mostly 5-lobed, the lobes triangular lanceolate, acute, mostly entire. Cup subpedunculed, saucer-shaped, the scales very smooth and closely appressed, margin thin, enclosing about one-third of the oval-globose acorn.

"Growing in clusters like Castanea pumila, 6–8 feet high, and bearing abundantly," very smooth. Leaves, including the petiole, 3–4 inches long, smooth and shining, the underside a little paler. A small villous tuft is found in the axial of one or two of the largest veins beneath. Petiole $\frac{1}{2}$–$\frac{3}{4}$ inch long. Sinus of the leaf rounded, extending about $\frac{2}{3}$ the way to the midrib. Acorns $\frac{1}{2}$ inch long, subglobose, marked longitudinally with pale lines. —This species is nearest allied to Q. palustris, but differs in its small size, smaller and differently shaped leaves. In the outline of the leaves and in the fruit, it has some resemblance to Q. ilicifolia; but the leaves are smooth, much larger and differently cut. fruit smaller and the cup less top shaped.—Stone Mt., Georgia. *H. W. Ravenel, Esq.*

Cyperus Iria, *Linn*.—Santee Canal, S. Car., *Mr. Ravenel*. —This interesting addition to our Flora I had taken for a new species and intended dedicating it to its discoverer, but Dr. Torrey, on the authority of a specimen from Nees, refers it as above. It was before known as a native only of the East Indies, China, and the Philippines. In the florets it has a remarkable similarity with C. flavicomus, but in the character of the inflorescence and in the seed it is very distinct.

Eleocharis albida, *Torr.*—Sullivan's Island, S. C., *Mr. Ravenel.*

Rhynchospora pallida, *n. sp.*—Culm rigid, acutely 3-angled, leafy, glaucous green, angles scabrous towards the summit. Leaves erect, carinate, ciliate-serrulate. Panicle terminal, capitate, compact, two of the bracteal leaves a little longer than the head. Spikelets very pale ferruginous, lanceolate, 1 flowered, 2–3 outer glumes shorter, ovate or lance-ovate, mucronate, the remaining two lanceolate, acute. Achenia obovate, smooth, compressed, reddish-brown with a paler disc, under a strong lens longitudinally striulate. Tubercle very short, depressed, apiculate. Setæ 3, $\frac{1}{3}$ the length of the achenium. Stam. 3. Style 2 cleft. —Wilmington, N. Car. June.

Culm 12–20 inches high. Achenium 1 line long. Has something of the aspect of the next species, but is stouter, with the panicles more compact and the glumes paler.

R. Chapmanii, *n. sp.*—Densely caespitose. Culms slender, obtusely 3-angled, striate, leafy, smooth. Radical leaves plane, the cauline filiform, short. Corymbs fasciculate, terminal, small, each of the divisions with a setaceous bract. Spikelets pale ferruginous, lanceolate, 1 flowered; glumes mucronate. Achenium oval and elliptic, compressed, pale or slightly ferruginous with a glassy disc on each side. Tubercle triangular, compressed, confluent, broad at base, $\frac{1}{4}$ the length of the achenium. Setæ 0! Stam. 2. Style long, 2 cleft.—Wilmington, N. C.—Aug. Sept.

Culm 12–20 inches high, nearly round. Achenium $\frac{1}{4}$ of a line long. Has some resemblance to R. alba. I have received this from the Santee (Ravenel); and also from Dr. Chapman of Florida, under the mss. name of R. Grayana. I learn from my excellent friend Mr. Carey, that it is also R. conferta. *Chapm. mss.* As I have distinguished the plant for more than fifteen years, I trust the Doctor will allow me to dedicate it to one who is worthy of more honor than I can confer.

R. divergens, *Chapm. mss.*—Culm filiform, glabrous, leafy. Leaves distant, setaceous, the margins serrulate toward the summit. Panicles axillary and terminal, corymbose, small, loose and spreading, the lateral ones pedunculate. Spikelets pedicellate, small, ovoid, acute, pale chestnut, florets all fertile. Achenium obovate, biconvex, very minutely striulate longitudinally or cancellate, pale or becoming a little dusky. Tubercle small, white, constricted at base. Style long deeply cleft. Stam. 1! Setæ 0!

Culm 6–12 in. high, slender. Leaves 2–4 in. long, involute. Axillary panicle one, distant. Achenium very small, $\frac{1}{3}$ of a line long. Resembles R. rariflora at first sight, but has the closest affinity with R. pusilla, *Chapm. mss.*, from which it differs in several particulars, especially in the achenium which is not rugu-

lose. They are apparently similar to R. polyphylla, *Vahl.* (MITROSPORA, *Nees.*)

This plant was sent me a year or two since from the Santee by Mr. Ravenel. I am indebted to Mr. Carey for the MSS. name of Dr. Chapman, which I have adopted instead of the one I had intended, (R. RAVENELII,) and under which I have distributed it.

The last two species, with R. pusilla, are peculiar among the North American species in the absence of hypogynous bristles; but they differ so much in habit that they can hardly be arranged together with reference only to this circumstance. R. divergens appears to be uniformly *monandrous.*

CAREX GLAUCESCENS, *Ell.* γ. POLYSTACHYA.—Spikes 8–12, small, nodding, mostly staminate at the summit.—Society Hill, S. Car., by the margins of ponds. This, like var. androgyna, (described in vol. xliv of this Journal,) is an autumnal variety, but much smaller and less showy than the other forms, and apparently produced by having been cropped early in the season by cattle.

C. ÆSTIVALIS, M. A. C.—In a late examination of the Herbarium of Mr. Durand of Philadelphia, I found that I had been anticipated by Schweinitz in the discovery of this and the following species. To this he had given the *mss.* name of C. DARLINGTONII, which I regret it should not have borne, in honor of the excellent botanist for whom it was named.

C. MITCHELLIANA, M. A. C.—This was also indicated by Schweinitz as new, but not named. Both of them were probably collected in the western part of N. Carolina.

C. STYLOFLEXA, *Buckley!*—Lower and middle region of N. Car., quite common. I have it also from Louisiana and Florida, and I think the same was gathered by Richardson in British America. It is to me a doubtful species.

C. TORTA, *Boott.*—Mountains of N. Carolina.

C. FLACCA, *Schreb.*—Raleigh, N. Car. Also in Alabama!

POLYPOGON MONSPELIENSE, *Desf.* Phleum pratense, *Ell.!*—Sullivan's Island, S. C.! *Dr. Buchman*, *Mr. Ravenel*, and on the coast of N. Car. as far north at least as Ocracoke Inlet!

PANICUM CARINATUM, *Torr.!* in Curt. Enum. Pl. Wilm.—P. digitarioides, *Carpenter!* Synops.—The following, derived from an examination of fresh specimens, is a more full account of this species than that in Boston Journ. of Nat. Hist., vol. i, 137.—Culm 3–4 ft. high, stout but rather flaccid, smooth, striate, hollow. Submersed nodes radiculate. Submerged sheaths leafless, loose, shorter than the nodes, the upper sheaths longer. Ligule a fimbriate margin. Leaves 6–8 in. long, 5–6 lines wide, rather

thick, smooth except on the margins near the summit, gradually acuminate, striate, the midrib vanishing about 2 in. from the base, imperceptible on the upper surface. Panicle closely appressed, branches alternate, angled, smooth, the lowest distant, 2 in. long, becoming gradually shorter and crowded at the summit. Flowers (5–7) subsecund upon short approximate alternate appressed branchlets, pedicellate, lance-ovate, acute, pale green. Lower glume lance-ovate, acute, $\frac{1}{2}$–$\frac{2}{3}$ the length of the upper, membranaceous, 3-nerved, the base surrounding the spikelet; upper glume nearly the length of the neutral flower, 5-nerved, acute. Outer palea of the neutral flower 3-nerved, the inner subequal, hyaline; both acute. Stam. 3. Herm. fl. a little shorter than the neutral, coriaceo-membranaceous. Stamens much exserted and covering the whole panicle with pale yellow anthers; filaments very slender, arachnoid. Stigmas large, densely plumose, ochroleucous.—Fl. May—July. Society Hill, S. Car. Also, Santee Canal, S. C., *Mr. Ravenel*, and Louisiana, *Prof. Carpenter*. Margin of ponds in water 2–4 feet deep.

In the specimens from localities here given, I have never been able to find the grain, and the flowers are very deciduous. The ovary is lanceolate, acute.

Art. XXXVIII.—*On Gibbsite and Allophane, from Richmond, Mass.;* by Prof. B. Silliman, Jr., of Yale College.

Gibbsite was first described by Dr. Torrey,* as a terhydrate of alumina ($\dddot{A}l\,\dot{H}^3$), and this constitution has been confirmed by the analyses of Dewey† and Thomson.‡ More lately, however, M. Hermann§ of St. Petersburg, has announced that the constitution of Gibbsite was that of a hydrous phosphate of Alumina $\dddot{A}l\,\dddot{P}+8\,\dot{H}$, and that the composition assigned to Gibbsite by Torrey, belongs only to the Hydrargillite of Rose. This result is quoted by Rammelsberg‖ in his third supplement, who regards it as quite conformable to his own admirable researches on the phosphates.¶ I was induced to repeat the analy-

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* New York Med. and Phys. Jour., No. 1, p. 68.

† Dewey. This Jour., i ser., ii, 2 and 9—where its close resemblance to Wavellite was noticed, and the minerals regarded as identical. It was at this time unknown to American mineralogists that Berzelius had but a short time before made known the real character of Wavellite as a phosphate and fluorid. Dr. Dewey in vol. iii, p. 239, (this Journal, 1821,) proposed the name Hydrargillite as the proper one for Gibbsite, then unknown by the latter name.

‡ Outlines of Mineralogy, i, 222. § Hermann, Jour. f. Pr. Chemie, xl, 32.

‖ Rammelsberg—Drittes supplement zu dem Handworterbuch, 1847, p. 18.

¶ Rammelsberg untersuchung einiger natürlichen und kunstlichen Verbindungen der Phosphorsäure; Pogg. An., B. lxiv, 407.

sis of Gibbsite, from a desire to satisfy my own doubts regarding it, and in the belief that it was quite probable that phosphate of alumina might have been regarded as alumina by those who had analyzed the mineral before M. Hermann, from the striking similarity of the two substances in nearly all their reactions. It will be seen in the sequel, however, that my results go to rëestablish the accuracy of Dr. Torrey's analysis and the ancient formula of this species.

I was bountifully supplied with excellent specimens of Gibbsite from the original locality in Richmond, Massachusetts, by the kindness of Dr. Stephen Reed, a gentleman well known to American mineralogists. Among the specimens sent to me were all the varieties of form which stalactitic and encrusting minerals ever assume, and many specimens were of remarkable size and perfection. Some specimens of the Gibbsite were covered with a pearly white lamellar mineral, encrusting and intimately associated with it, and which closely resembled allophane, which mineral, analysis proves it to be.

Physical Description.—Gibbsite occurs in stalactites often several inches long, in mamillary masses, and incrustations covering broad surfaces of iron ore and ferruginous rocks. The stalactites have a radiating subfibrous structure, and always enclose particles of iron ore as a nucleus. The crusts are generally the most free from foreign matter. No crystalline structure could be detected in any of the specimens. *Hardness* 3·5—3·75. *Density* 2·389. *Lustre* faint subvitreous. *Streak* white. *Color* white and grayish white, sometimes reddish and greenish. Yields a strong argillaceous odor when moistened or breathed on. Texture tough and adheres strongly to the polished surface of the agate pestle and mortar.

Pyrognostic characters.—In the close tube gives off water abundantly which is neutral, but has a decided empyreumatic odor. On charcoal it decrepitates strongly from the escape of water, and finally becomes opake; phosphoresces; moistened with nitrate of cobalt-solution, it gives when heated upon charcoal a bright blue slag like pure alumina. It dissolves to a transparent bead in salt of phosphorus acid, and in borax. Treated with the iron wire for phosphoric acid not the least evidence could be obtained, according to the method advised by Berzelius. By employing the method advised by Vanquelin and Thenard for detecting phosphoric acid in small quantity by means of potassium in a deep tube, a decided but not strong odor of phosphuretted hydrogen was obtained.

Chemical characters.—The finely pulverized mineral dissolves at once in strong potash or soda ley, leaving only a few flocs of peroxyd of iron. In boiling concentrated chlorohydric acid it is only in part soluble, unless after a very long time and with re-

peated doses of fresh acid. Concentrated sulphuric acid dissolves it with great energy. If the pulverized mineral is made into a paste with Nordhausen acid and the temperature be slightly raised, the action is so violent as to completely decompose the mineral in an instant, converting the whole into a solid mass with an evolution of great heat. This mass is perfectly soluble in water save a few milligrammes of silica and hydrous oxyd of iron mechanically present. It is evident therefore, that either sulphuric acid or the caustic alkalies must be used in attacking this mineral.

Water.—The water of the mineral was determined on three portions, selected from the purest specimens—the powdered mineral was dried at 212°, cooled over sulphuric acid, and ignited in a covered platinum crucible until a constant weight was obtained. The three trials gave successively

35·206—33·828—33·420. Mean 34·151 pr. ct. which is a little too low for the formula.

1st *Analysis.*—My first analysis of this mineral was made by the ordinary course of inorganic analysis without recourse to any special means for the separation of phosphoric acid.

1·565 grammes substance was dissolved in concentrated sulphuric acid, evaporated to dryness, and redissolved in water. The insoluble matter (silica and peroxyd of iron) weighed ·0278 gramme. The $\ddot{A}l$ was separated from the filtrate by ammonia and weighed ·993 gramme. The filtrate from the alumina yielded on concentration and treatment with phosphate of soda, a small quantity of magnesia, weighing ·0047 gramme. No lime was present. The results of this analysis yield the following summary.

		Found.
Alumina,	·9930 =	63·446
Water,	·5395* =	34·477
Magnesia,	·0047 =	·300
Insoluble residue,	·0278 =	1·777
	1·5650 =	100·000

			Calculated.	
$\ddot{A}l$	1 at.	=	642·33	= 65·56
$\dot{H}$	3 "	=	337·44	= 34·44
			979·77	100·00

This analysis requires therefore, the formula $\ddot{A}l\dot{H}^3$. If the magnesia and insoluble matter are regarded as displacing so much alumina, the requirements of the formula will be exactly met, i. e., 63·446 + 2·076 = 65·522.

* By the difference.

I have not had the opportunity of seeing the original memoir of M. Hermann, in which he no doubt details his method of separating phosphoric acid from alumina. In the Annuaire de Chimie of MM. Millon and Reiset, for 1848, p. 155, an abstract is given of this paper of M. Hermann, which states that the results of Rose's analysis of hydrargillite, in which this chemist detected a small portion of phosphoric acid, led him to the re-analysis of Gibbsite, and that the results of this chemical examination gave the formula already quoted from Rammelsberg in the commencement of this article. His analysis of hydrargillite, states—

Water, ...	34·54
Phosphoric acid, ...	1·43
Alumina, ...	64·03
	100·00

For the separation of phosphoric acid from alumina in Gibbsite, M. Hermann states, as quoted in the Annuaire, that he "dissolved the Gibbsite in *hydrochloric* acid, and neutralized the solution by chalk—the precipitate obtained on the addition of ammonia was treated by hydrate of soda to dissolve out the alumina. The residue consisted of phosphate of lime."

2d *Analysis*.—As before stated, I find the Gibbsite not entirely soluble in hydrochloric acid. I therefore dissolved it in caustic soda, acidulated the solution with hydrochloric acid, neutralized with limewater, precipitated by ammonia, collected the precipitate by filtration, and re-dissolved the alumina by caustic soda. A small residue insoluble in this menstruum remained (=·036 grm.) which was presumed to be phosphate of lime colored by a little phosphate of iron. It is to be remarked, however, that the blowpipe gave very equivocal evidence of this precipitate containing any phosphoric acid. The alumina was then separated by carb. ammonia and weighed. The results of this analysis were on 1·0447 grammes substance taken:—

$\dddot{Al}$	·67859 grm.	=64·955
$\dddot{P}$	·00751 "	·590
H	·35000* "	34·073
Mg		·300
Insol.	·00860	·082
	1·04470	100·000

3d *Analysis*.—This last result was confirmed by the analysis of another portion of the mineral by the method proposed by Rammelsberg for the separation of phosphoric acid and alumina.

* By the difference.

This method is as follows: The mineral is dissolved in sulphuric acid, and a sufficient quantity of sulphate of potash is added. The whole solution (which should be not very bulky), is then mingled with a large quantity of strong alcohol ($\frac{S}{1}\frac{0}{0}$) and allowed to stand for some hours. In this way alum and sulphate of potash separate, while $\dddot{S}$ and $\dddot{P}$ remain in solution. Then filter, wash the precipitate out with alcohol, dissolve the residue in water and precipitate the alumina by ammonia. The alcoholic filtrate, containing the $\dddot{S}$ and $\dddot{P}$ is next evaporated to expel the alcohol, supersaturated with ammonia and precipitated by chlorid of calcium. The precipitate always containing sulphate of lime, is washed only for a short time; it is then dissolved in hydrochloric acid and diluted with weak alcohol. Gypsum separates on standing and is removed by filtration, and from the filtrate, ammonia separates pure phosphate of lime.*

1·432 grammes of Gibbsite in fine powder were treated by this process, with every precaution to ensure accuracy. I obtained—

$\dddot{Al}$	= ·9209	64·160
$\dot{Ca}_2\dddot{P}$	= trace	trace
$\dot{H}$	·4877†	34·151
$\dot{Mg}$		·300
Insoluble	·0233	1·627
	1·432	100·238

That no doubt should remain, or any room for error, I further reanalyzed the alumina obtained from the analysis of the first portion of Gibbsite (I.) by the method of Berzelius, which I have often before used with success for the separation of phosphoric acid from alumina. It is briefly this: The substance is fused with 6 parts of pure carbonate of soda, and 1½ parts of pure silica. The phosphoric acid is thus transferred to the soda, and the alumina remains as an insoluble silicate, on treating the fused mass with successive portions of hot water. The filtrate is treated with bicarbonate of ammonia and boiled for some hours to separate a portion of basic silicate of alumina, which the alkaline menstruum had dissolved. The filtrate containing all the $\dddot{P}$ is acidulated with HCl boiled to expel carbonic acid, and being evaporated to a small bulk, ammonia and sulphate of magnesia are added to the cold solution, and the ammonio-magnesian phosphate allowed to crystallize out.

* Pogg. Ann., B. 54, 406.

† By the difference.

4th *Analysis.*—·908 gramme of alumina obtained in analysis No. 1, treated by the above process, gave

$$0{\cdot}0126\ \dot{M}g\ \dddot{P} = {\cdot}677 \text{ per cent. of phosphoric acid.}$$

This quantity of phosphoric acid is equivalent to

·753 per cent. of phosphate of alumina.

The remainder was only alumina.

From the foregoing results, it is evident that the Gibbsite of Richmond, Massachusetts, corresponds to the formula first given, $\ddot{A}l\ \dot{H}^3$, which requires

$\ddot{A}l$	65·156
$\dot{H}$	34·440
	100·000

and the mean results of these analyses correspond very closely to the calculated per-centages. The phosphoric acid is therefore like the magnesia, iron and silica contained in Gibbsite, only a contingent impurity.

Allophane.

I have already remarked that some specimens of Gibbsite are coated by a hyaline crust, cleaving in laminated scales, sometimes opake white and pulverulent, and again perfectly limpid and colorless. It is extremely brittle, easily reduced to powder, and yields easily to the knife. Before the blowpipe it loses water and falls to a white powder, or loosely coherent slag. In salt of phosphorus leaves a siliceous skeleton. Gives off water abundantly in the close tube; this water is neutral. With nitrate of cobalt on charcoal it yields a blue slag, and it dissolves with effervescence in carbonate of soda.

A qualitative examination gave evidence of the presence of water, alumina, silica, and magnesia. The whole character of the mineral left no doubt that it was allophane, and the chemical analysis confirmed this conclusion. It was not easy to find a portion of the mineral which was perfectly homogeneous—or to separate entirely all those portions which had evidently undergone more or less decomposition.

After several analyses and repeated determinations of the quantity of water, I arrived at the following result, which if we regard magnesia as an accidental constituent, and distribute it and the loss between the silica and alumina, will give us almost precisely the per-centages required by the formula $\ddot{S}i^2\ \ddot{A}l^3 + 15\dot{H}$, viz:—

	Atoms.		Calculated.	Found.
2 $\dddot{S}i$	1154·62	=	24·211	22·654
3 $\dddot{A}l$	0926·99		40·408	38·768
15 $\dot{H}$	1687·20		35·421	35·240
	4768·81		100·000	96·662
				2·833 magnesia.
				0·505 loss.
				100·000

If the magnesia is regarded as an essential constituent of the mineral, it gives a complicated and improbable formula, while it is not at all remarkable that a mineral formed by infiltrating waters as this evidently is, should contain a notable amount of foreign impurities.

I was struck with the resemblance which exists between these two associated species and the stalactitic concretions of hydrated aluminous silicates brought by Mr. Dana from the lava caves of volcanic Islands in the Pacific. These I have long since examined, and the results are contained in the Geological Report of the U. S. Exploring Expedition, by Mr. Dana.

There can no longer be any doubt of the identity of the Hydrargillite of Rose with Gibbsite ;—the former is the crystalline, the latter the amorphous variety of the same species. It is not impossible that this same locality may furnish specimens of massive Wavellite, and perhaps it was such an one which gave to M. Hermann the result which has called out this article. The phosphoric acid of both Hydrargillite and Gibbsite is in too small quantity to be regarded as an essential constituent.

In conclusion I would say, that on a former occasion, in making a cursory qualitative examination of Gibbsite, I detected *silica* in it, and so reported it to Mr. Dana, and the statement is repeated in his smaller work. I have now no doubt that the portion of the mineral then examined, was contaminated with a portion of allophane—in fact, the examination was made upon the same specimens, in which, by closer observation, I have since detected the latter mineral. It requires some care to separate the two entirely, and I have little doubt that the silica, mentioned by Dr. Thomson in his analysis of Gibbsite, was derived from the same intermixture of the two species.

Analytical Laboratory, April 1, 1849.

ART. XXXIX.—*Notice of a Novel Mode of Discharging a Leyden Battery, with an explanation of its theory ;* by J. H. LANE, of the Patent Office, Washington.

IN the London Mechanic's Magazine, vol. xlix, page 84, we notice a mode of discharging a Leyden battery, which is very beautiful in theory, and if not entirely new, is at least generally unknown, and some notice of it is therefore deemed proper in this Journal.

It has been publicly exhibited on a large scale, in a course of lectures delivered by Mr. Baggs, in the Polytechnic Institution, and an epitome of which was communicated to the Mechanic's Magazine, by John Mac Gregor, Esq.

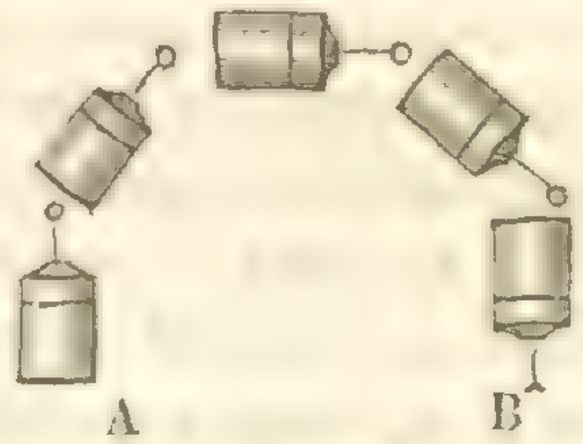
The arrangement of the jars in the new mode of discharging them, is precisely that which has often been employed in charging them, that is, in a series with the knob of each in connection with the outer coating of the next in the series. In the present case however, it is only in discharging that they are thus arranged. They are charged separately, or are first connected together in a battery in the ordinary way, with all the outer coatings connected together and with the earth and all the inner coatings connected and thus charged. Then when ready to discharge, they are by a simple movement all insulated and arranged in a series as above described, which series may be made to take a semicircular or U form, in order to bring the knob of the last jar in the series, into convenient proximity to the outer coating of the first jar. The effect of this arrangement of the charged jars is to multiply the *intensity* in a manner precisely analogous to that of the galvanic battery, so that if the outer coating of the first jar be supposed to be connected with the earth, and the number of jars twelve, the *knob* of the last jar of the series will be twelve times more highly electrified than the *knob* of either jar was before being thrown into series. Consequently, the disruptive force or space-penetrating power of the spark, will be correspondingly multiplied, and Mr. Baggs is said to have discharged his battery of twelve large jars through a space of about three feet. It is hardly necessary to remark, that in this way of discharging the battery, the *quantity* of the spark is only that of a single jar. Hence to pursue experiments on this plan with any satisfaction, large jars must be used, with an abundant source of electricity from a powerful machine. Mr. Baggs employed a steam electric machine.

The method employed by him, of making the necessary changes of arrangement in the jars, is quite simple. Each jar is supported in a horizontal position on a vertical spindle, and the

several jars are arranged as shown in fig. 1, to be charged; but part of a revolution given to each spindle will bring them into series as show in fig. 2, when the discharge will take place between A and B.

Fig. 1.

Fig. 2.



That the multiplication of the intensity will actually take place as above stated, may easily be proved from the known phenomena of a single jar. The general principle concerned, is that if a ball N be connected with the outer coating of a charged jar and a ball P with the inner coating, the difference between the quantities* of free electricity in the balls N and P, is constant, or approximately so, though the quantities themselves be varied.

Thus, let us suppose the jar to be charged to such a degree that with N in its natural state, P is found by the electrometer to have a quantity of free electricity denoted by a. Then, the jar being insulated, it is known that if a quantity q of free electricity be given to N, a corresponding additional quantity is set free from the inner coating of the jar in consequence of the diminished induction of the outer coating, and thus P will exhibit approximately, and probably exactly, the quantity $q+a$ of free electricity. Hence, if many other jars be also charged to the same degree, and connected in a series with the outer coating of the first in connection with the earth, the P of the first jar must have the quantity a of free electricity, the second jar having its $N=a$ must have its $P=2a$, and the third jar having its $N=2a$ must have its $P=3a$, &c.

"We have thus," says Mr. Mac Gregor, "a new feature introduced into our manipulation of Franklin electricity—the simultaneous change in position of each jar of the battery; and whilst its first results enable the electrician to exhibit a disruptive spark of great power, we can set no limits to the expectations we may indulge in from its full development."

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*The word quantity in this connection is not used in its more common sense, but is adopted as being best suited to my present purpose. I mean by it the quantity *of free* electricity in a *unit* of surface of the ball N or P. In this sense the *quantity* of *free* electricity is a measure of the *intensity* or rather *tension*.

Art. XL.—*On the Action of Nitric Acid on Sebacic Acid;* by Adolph Schlieper.

It is quoted in all chemical hand-books, that sebacic acid is not altered by treatment with nitric acid; but the similarity of many of its physical properties with benzoic acid authorized the conjecture that, like the latter it might be converted into *nitro-sebacic acid* $C_{10}H_7O_3NO_4$. In all cases it was interesting to know, if the action of nitric acid on this constant product of decomposition of oleic acid at high temperatures, did not cause the formation of one or more of those acids which Laurent produced by direct action on oleic acid by this agent.

The sebacic acid employed in this research was obtained by dry distillation of the crude commercial oleic acid. The distillate was boiled with water several times, the watery extracts saturated with carbonate of soda, and evaporated to dryness; to remove the caprylate and caprinate of soda; the dry saline mass was then exhausted with hot absolute alcohol, which left the sebacate of soda undissolved. The latter was then dissolved in water and the sebacic acid precipitated by addition of muriatic acid; after being purified by several repeated crystallizations from water, it presented itself as a loose, very light, white mass, consisting of small shining scales.

To examine the formation of nitro-sebacic acid, one part of sebacic acid was heated with 20–30 parts crude nitric acid, spec. gr. 1·4, in a spacious matrass; no solution is effected when cold, but it takes place perfectly a little below the boiling point; at the same time the orange colored vapors of hyponitrous acid and the like color which the liquid assumes, indicate a decomposition of the sebacic acid. The nitric solution was then kept at a continual slow boiling on a sandbath, in such a manner that the evaporating nitric acid condensed for the greater part in the long neck of the matrass and flowed back. After 2–3 hours boiling, a small part of the solution was poured out, to see if the formation of a nitro-sebacic acid had taken place, though the continual but very slow development of red vapors, indicated clearly, that the decomposition was not yet finished.

The hot nitric solution, mixed with 8–10 times its volume of cold water, separated a great quantity of probably unaltered sebacic acid, which having been washed out and dried, showed all the physical properties of that substance. I prepared and analyzed the silver salt of acid so obtained, and thus proved that it was only unaltered sebacic acid. 0·312 grm. of the silver salt gave 0·161 grm. silver, which corresponds to an amount of oxyd of silver of 55·41 per cent. Sebacate of silver contains 55·76 per cent. oxyd of silver.

I may here mention an easy method of obtaining perfectly snow-white sebacic acid, this material having generally a yellowish tint. It is sufficient, just to boil one part of impure sebacic acid with 5–6 parts of nitric acid, spec. gr. 1·35, and then mix the solution with a great quantity of boiling water; by cooling, the sebacic acid crystallizes perfectly pure.

The rest of the solution of sebacic acid in nitric acid, was kept continually boiling, till the entire cessation of the formation of nitric oxyd, constantly renewing the evaporating nitric acid. The oxydation takes place very slowly; it required eight days for a quantity of about 200 grains of sebacic acid. After the solution had changed its orange to a nearly white color, and the development of nitric oxyd ceased, the contents of the matrass were poured into a flat basin, diluted with an equal volume of water, and on the waterbath the nitric acid slowly driven off, using the precaution of adding from time to time a small quantity of water. The white residue was then dissolved in water, filtered and evaporated to a syrup, on the waterbath; then allowed to crystallize over sulphuric acid. Regular crystals could not be obtained perhaps, because the quantity of the solution was not sufficient; but the whole solution solidified very soon and became a white crystalline mass somewhat sticky, appearing like pure grape sugar crystallized in a similar way. This substance, in a perfectly pure state, is a strong acid, and the only product which results from the action of nitric acid on sebacic acid. It is, as will presently be proved, identical in composition and quality with *pyrotartaric acid*, as far as a comparison was possible with the fluctuating reports we possess about the latter.

For analysis, the acid was dried over sulphuric acid, and afterwards melted, but without sustaining any loss in its previous weight; it was burnt with chromate of lead and gave the following results:

(1.) 0·349 grm. substance gave 0·579 grm. carbonic acid, and 0·1915 grm. water.

(2.) 0·3293 grm. substance gave 0·5485 grm. carbonic acid, and 0·1805 grm. water.

From this is derived the formula:

$C_5 H_4 O_4 = C_5 H_3 O_3 HO$ = hydrate of pyrotartaric acid.

	Calculated.		Found.	
			I.	II.
C_5	30	45·45	45·27	45·42
H_4	4	6·06	6·09	6·09
O_4	32	48·49	48·64	48·49
$C_5 H_4 O_4 = 66$		100·00	100·00	100·00

Hence one equivalent of sebacic acid takes up five equivalents of oxygen by oxydation with nitric acid, and changes itself in two equivalents of the hydrate of pyrotartaric acid.

1 equivalent of sebacic acid, $=C_{10}H_8O_3$
5 " " oxygen, $=O_5$

2 equivalents of the hydrate of pyrotartaric acid $=C_{10}H_8O_8=2(C_5H_3O_3,HO)$

This acid thus differs from lipinic acid, which it resembles in many properties, only by one equivalent less of oxygen. The acid in question has the following qualities, which coincide very nearly with those of pyrotartaric acid, as stated by Pelouze; the very slight deviations in regard to the crystallization of the acids, it was impossible for me to reconcile, on account of the small quantity of the new acid which I could command. The acid presents itself as a perfectly white, slightly crystalline mass, a little sticky, and permanent in the air; heated in a waterbath, it became half fluid, but heated a few degrees above 100° Centigrade, it melted into a watery clear fluid, solidifying when cooled into a crystalline mass. Very cautiously heated on platinum, it volatilizes entirely, evolving a white suffocating vapor. Heated between two watch crystals it sublimes, leaving a carbonaceous residue, in strong shining prismatic needles, which show all the reactions of the unsublimed acid. The acid is inodorous, and has a very acid taste, similar to that peculiar to succinic acid. It is easily soluble in water, alcohol and ether, also in concentrated sulphuric acid without being decomposed. Heated with alcohol and sulphuric acid the ether of this acid is readily formed, which is distinguished by a peculiar aromatic odor. The watery solution drives out carbonic acid with effervescence, and forms gum-like salts with potash, soda and ammonia, when evaporated briskly, but whose concentrated solutions allowed to evaporate above sulphuric acid, dry to crystalline masses. The ammonia salt loses ammonia in evaporating and becomes acid. The alkaline salts are soluble in alcohol, furnish no precipitates with baryta and lime salts, with chlorid of iron a flocculent brownish red precipitate, soluble in a pretty large quantity of boiling water; with copper salts results a light green precipitation. With acetate of lead, no precipitate results, but after two to three hours the mixtures of the solutions not too much diluted, deposit a white lead-salt in granules, principally adhering to the sides of the vessels; once separated they are difficultly soluble in water. If an addition of alcohol is made to the mixed solutions of acetate of lead and the ammonia salt of the acid, a thick white precipitate is produced directly, melting to small drops when heated, and evidently the same precipitate which deposits after a longer standing of the solutions, without additions of alcohol. The ammonia salt gives

with basic acetate of lead a thick curdy precipitate, cohering after some hours, easily soluble as well in acids as in an excess of basic acetate of lead. Nitrate of silver is precipitated by the ammonia salt in white flocs very like fresh precipitated alumina.

All these qualities mentioned, agree so perfectly with those of pyrotartaric acid as described by Pelouze, that, considering the similarity of the composition of both acids, I do not hesitate in the least to proclaim the identity of pyrotartaric acid with the acid obtained by oxydation of sebacic acid with nitric acid.

From the statements of Weniselos my own differ, only in regard to the ammonia salt, which the first pretends to have obtained in fine crystals; and in regard to the neutral lead salt, which ought to deposit itself after a certain time in fine needles, whereas Pelouze, as well as myself, obtained only granulated precipitates, under the same conditions.

For further analysis I selected the silver salt, which was prepared by precipitating the nitrate of silver with the ammonia salt of the acid; but I am sorry to say, that I did not succeed in obtaining it of a constant composition, which is very remarkable in a silver salt. I procured from salts of two different preparations 2–3 per cents. of oxyd of silver less than the formula AgO, PT required, though the acid combined with it, calculated by itself, after deduction of the mean amount of oxyd of silver, corresponded exactly to the formula of the anhydrous acid.

The silver salt is very sensible to light, dries slowly and forms semi-transparent hard pieces, very like the dried hydrate of alumina; which become brownish white when powdered. The analysis gave the following results:

I. *Preparation.*—(1.) 0·3358 grm. silver salt gave 0·2005 grm. silver = 0·2153 grm. oxyd of silver.

(2.) 0·4038 grm. silver = 0·2415 grm. silver = 0·2585 grm. oxyd of silver.

(3.) 0·6715 grm. silver gave by combustion with chromate of lead, 0·465 grm. carbonic acid, and 0·1245 grm. water.

II. *Preparation.*—(1.) 0·3355 grm. silver salt gave 0·2027 Ag = 0·21777 oxyd of silver.

(2.) 1·0034 grm. silver salt, burnt with chromate of lead, gave 0·675 grm. carbonic acid and 0·178 grm. water.

This calculated in per cent. gives,

	I. Preparation.			II. Preparation.	
	I.	II.		I.	II.
AgO	64·11	64·01	. .	64·88	. .
C	. .	. .	18·88	. .	18·34
H	. .	. .	2·06	. .	1·97

Pyrotartrate of silver would correspond with:

		Calculated.
1AgO	116	67·05
5C	30	17·35
3H	3	1·73
3O	24	13·87

If now the mean amount of oxyd of silver is deducted from the analysis as above, and the equivalents of carbon, hydrogen and oxygen combined with it, calculated on the hundred parts, then we obtain exactly the percentage numbers of the anhydrous pyrotartaric acid as will be seen from the following comparison.

		Calculated.	Found.	
			I.	II.
C_5	30	52·63	52·53	52·22
H_3	3	5·26	5·73	5·60
O_3	24	42·11	41·74	42·18
$C_5 H_3 O_3 = 57$		100·00	100·00	100·00

The lead precipitate which results from basic acetate of lead in the ammonia salt of the acid, has been dried and analyzed.

(1.) 0·321 grm. substance gave 0·3195 grm. sulphate of lead =0·23503 oxyd of lead.

(2.) 0·4655 grm. substance gave 0·460 sulphate of lead.

(3.) 0·3585 grm. substance (of a different preparation) gave 0·3585 grm. sulphate of lead.

This amount of oxyd of lead corresponds exactly with the formula:

$C_{10} H_7 O_7 + 3PbO = 2(PbO, C_5 H_3 O_3) + PbO, HO$, as results from the comparison of the found and calculated values.

		Calculated.	Found.		
			I.	II.	III.
3PbO	335·1	73·12	73·21	72·70	73·0
$C_{10} H_7 O_7$	123·0	28·88	. .	. .	. .

A further comparison of this acid with pyrotartaric acid, will be possible only, when the latter has been submitted to a more fundamental investigation; but from the statements above, the identity of these acids can hardly be doubted.

Lowell, April 4th, 1849.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Crystalline Polarity of Bismuth and other bodies, and on its Relation to the Magnetic Form of Force*; by Dr. Faraday, (Proc. Roy. Soc., Athen., No. 1103, Dec. 16.)—The author states that in preparing small cylinders of bismuth by casting them in glass tubes, he had often been embarrassed by the anomalous magnetic results which they gave, and that having determined to investigate the matter closely, it ended in a reference of the effects to the crystalline condition of the bismuth, which may be thus briefly stated. If bismuth be crystallized in the ordinary way, and then a crystal, or a group of symmetric crystals, be selected and suspended in the magnetic field between horizontal poles, it immediately either points in a given direction or vibrates about that position, as a small magnetic needle would do, and if disturbed from this position it returns to it. On resuspending the crystal so that the horizontal line which is transverse to the magnetic axis shall become the vertical line, the crystal then points with its maximum degree of force. If it be again resuspended so that the line parallel to the magnetic axis be rendered vertical, the crystal loses all directive force. This line of direction therefore, which tends to place itself parallel to the magnetic axis, the author calls the *magne-crystallic axis* of the crystal. It is perpendicular, or nearly so, to the brightest and most perfect of the four cleavage planes of the crystal. It is the same for all crystals of bismuth. Whether this magne-crystallic axis is parallel or transverse to the magnetic axis, the bismuth is in both cases repelled from a single or the stronger pole; its diamagnetic relations being in no way affected. If the crystal be broken up, or if it be fused and resolidified, and the metal then subjected to the action of the magnet, the diamagnetic phenomena remain, but the magne-crystallic results disappear, because of the confused and opposing crystalline condition of the various parts. If an ingot of bismuth be broken up and fragmentary plates selected which are crystallized uniformly throughout, these also point; the magne-crystallic axis being, as before, perpendicular to the chief plane of cleavage, and the external form, in this respect, of no consequence. The effect takes place when the crystal is surrounded by masses of bismuth, or when it is immersed in water or solution of sulphate of iron, and with as much force apparently as if nothing intervened. The position of the crystal in the magnetic field is affected by the approximation of extra magnets or of soft iron; but the author does not believe that this results from any attractive or repulsive force exerted on the bismuth, but only from the disturbance of the lines of force or resultants of magnetic action, by which they acquire as it were new forms; and, as the law of action which he gives is, that *the line or axis of magne-crystallic force tends to place itself parallel, or as a tangent, to the magnetic curve or line of magnetic force, passing through the place where the crystal is situated*, so the crystal changes its position with any change of direc-

tion in these lines. After noticing the magne-crystallic condition of various bodies, the author enters upon a consideration *of the nature of the magne-crystallic force.* In the first place he examines closely whether a crystal of bismuth has exactly the same amount of repulsion, diamagnetic or otherwise, when presenting its magne-crystallic axis *parallel* or *transverse* to the lines of magnetic force acting on it. For this purpose the crystal was suspended either from a torsion balance, or as a pendulum thirty feet in length, but whatever the position of the magne-crystallic axis, the amount of repulsion was the same. In other experiments, a vertical axis was constructed of cocoon silk, and the body to be examined was attached at right angles to it as radius; a prismatic crystal of sulphate of iron, for instance, whose length was four times its breadth, was fixed on the axis with its length as radius and its magne-crystallic axis horizontal, and therefore as tangent; then, when this crystal was at rest under the torsion force of the axis, an electro-magnetic pole with a conical termination was so placed that the axial line of magnetic force should be, when exerted, oblique to both the length and the magne-crystallic axis of the crystal; and the consequence was, that, when the electric current circulated round the magnet, the crystal actually *receded* from the magnet under the influence of the force, which tended to place the magne-crystallic axis and the magnetic axis parallel. Employing a crystal or plate of bismuth, that body could be made to *approach* the magnetic pole under the influence of the magne-crystallic force; and this force is so strong as to counteract either the tendency of the magnetic body to approach or of the diamagnetic body to retreat, when it is exerted in the contrary direction. Hence the author concludes that it is neither attraction nor repulsion which causes the set or determines the final position of a magne-crystallic body. He next considers it as a force dependent upon the crystalline condition of the body, and therefore associated with the original molecular forces of the matter. He shows experimentally, that, as the magnet can move a crystal, so also a crystal can move a magnet. Also that heat takes away this power just before the crystal fuses, and that cooling restores it in its original direction. He next considers whether the effects are due to a force altogether original and inherent in the crystal, or whether that which appears in it is not partly induced by the magnetic and electric forces; and he concludes, that the force manifested in the magnetic field, which appears by external actions and causes the motion of the mass, is chiefly, and almost entirely *induced*, in a manner subject indeed to the crystalline force and additive to it; but at the same time exalting the force and the effects to a degree which they could not have approached without the induction. To this part of the force he applies the word *magneto-crystallic*, in contradistinction to magne-crystallic, which is employed to express the condition or quality or power which belongs essentially to the crystal. The author then remarks upon the extraordinary character of the power, which he cannot refer to polarity, and gives expression to certain considerations and views which will be best learned from the paper itself. After this, he resumes the consideration of Plucker's results "*upon the repulsion of the optic axes of crystals*," already referred to, and arrives at the conclusion that his results and

those now described have one common origin and cause. He then considers Plucker's results in relation to those which he formerly obtained with heavy optical glass and many other bodies. In conclusion he remarks, "how rapidly the knowledge of molecular forces grows upon us, and how strikingly every investigation tends to develop more and more their importance and their extreme attraction as an object of study. A few years ago magnetism was to us an occult power affecting only a few bodies; now it is found to influence all bodies, and to possess the most intimate relations with electricity, heat, chemical action, light, crystallization, and, through it, with the forces concerned in cohesion; and we may, in the present state of things, well feel urged to continue in our labors, encouraged by the hope of bringing it into a bond of union with gravity itself."

2. *Method of obtaining crystalline combinations by Heat, and of reproducing thereby various mineral species;* by M. EBELMAN, (Comptes Rendus de l'Acad. des Sci., t. xxv, pp. 279 and 661; Annuaire de Chemie, 1848, p. 141.)—It is known that borax, boracic acid, phosphoric acid, and the alkaline phosphates, dissolve metallic oxyds with ease, at a certain temperature, and abandon them at a much higher temperature by virtue of their volatility. These bodies enjoy, therefore, in regard to the oxyds which they hold in solution, the function which water possesses at the ordinary temperature, or at temperatures more elevated in relation to bodies held in solution by it,—that very often on evaporating it leaves such bodies in a crystalline condition. This simple principle has led M. Ebelman to a method which will enrich chemistry by the dry method, with a great number of novel combinations, and which will establish the most intimate connection between mineralogy and chemistry. On mingling together, for example, alumina and magnesia in a little larger proportion than they exist in spinel, with a portion of fused boracic acid, and exposing the mixture to the most elevated temperature of a porcelain furnace, octahedrons are obtained which possess the composition and properties of spinel. These crystals are rose-red or blue according as the oxyd of chrome or of cobalt is used. M. Ebelman has obtained in this way chrysoberyl Al^2O^3, GlO, and many other aluminates. He has obtained the compound $Cr^2O^3 + MgO$, crystallized in regular octahedrons. He has prepared many varieties of chrome iron which all present regular octahedrons with the usual mineralogical characters; in their composition they approach spinel and the compound $\ddot{C}r\,Mg$.

By the aid of this process, M. Ebelman has also obtained the emerald and peridot crystallized.

Boracic acid is too volatile to aid in crystallizing alumina, and in this case he employed borax. By the addition of a little oxyd of chrome, crystals of red ruby are obtained, having the formula of transparent corundum.

3. *Researches upon Wax;* by BENJAMIN COLLINS BRODIE, (Philos. Mag. for Sept. and Nov., 1848, from the Phil. Trans.)—This research has settled a hitherto disputed subject in a most satisfactory manner, and the care exhibited in the processes employed and the analytical results entitle it to great confidence.

Bees-wax is, by the action of boiling alcohol, separated into a soluble portion which has been called *cerine* and a *comparatively* insoluble substance designated *myricine*. The cerine by repeated solution in boiling alcohol may be obtained in an approximately pure state; it then fuses at about 70° or 72° C. and is readily soluble in caustic potash. If a boiling alcoholic solution of this is mixed with an alcoholic solution of acetate of lead also boiling, a voluminous precipitate is obtained which is boiled with repeated portions of alcohol as long as this takes up anything. The lead salt is then decomposed by acetic acid and yields a highly crystalline acid which separates from its alcoholic solution on cooling, in fine grains; it melts at 78° C. To this substance the name of *cerotic acid* is given; the analysis of the acid and its salts shows that it is monobasic and has the formula $C_{54}H_{54}O_4 = C_{27}H_{54}O_2$ according to M. Gerhardt's notation. The ether is obtained by the usual process, and its analysis confirms the composition above ascribed to the acid. By the action of chlorine a substitutive product is obtained, which formula is $C_{27}(H_{42}Cl_{12})O_2$; it is still an acid and yields an ether corresponding to the one just noticed. Cerotic acid when pure is volatile for the greater part, without change, but when mixed with the other materials of the wax it is completely decomposed by distillation. To prove that the cerotic acid is really an ingredient of the wax and is not found in the process, Mr. Brodie has shown that by repeated crystallization of the cerine from ether, it at last acquires the fusing point and composition of the cerotic acid obtained by the other process. The proportion of cerotic acid as ascertained by precipitation with acetate of lead, was found in one specimen to be 22 per cent.; and it was generally present in the English wax as submitted to examination. The investigations upon the tree-wax of China, however, showed the complete absence of cerotic acid and gave rise to the discovery of the alcohol of that acid.

This wax which is an article of commerce from China, appears from the best accounts to be the product of an insect, the *Coccus ceriferus*, which feeds upon the *Rhus succedaneum* and some other trees. It is white and crystalline, resembling spermaceti, but is harder, more brittle, and more fibrous in its structure; it fuses at 83° C., and is little soluble in alcohol or ether, but dissolves readily in naphtha and may be crystallized from it. It is insoluble in solution of potash but by fusion with caustic potash is decomposed. By decomposing the solution of this in water by chlorid of barium and washing the baryta salt with alcohol, a neutral crystalline substance is obtained which when purified by crystallization in ether melts at 79° C. Its analysis leads to the formula $C_{54}H_{56}O_2$ or $C_{27}H_{56}O$. It is evidently, therefore, homologous with spirit of wine and ethol and is the alcohol of cerotic acid, the homologue of acetic and etholic acids. To this new alcohol, the author applies the name of *cerotine*; but *cerotol* should be substituted in accordance with the nomenclature of the French chemists, to which we have generally conformed, and which restricts the termination *ine* or *in* to alkaloids. When heated with potash-lime, cerotol evolves hydrogen gas and yields cerotate of potash, the identity of which with that obtained from bees-wax was determined by analysis.

Cerotol is soluble in concentrated sulphuric acid and water, precipitates from the solution a new substance soluble in alcohol and to some extent in water; it may be crystallized from ether; its analysis leads to the formula $SO_3\,C_{54}\,H_{55}\,O+HO$, and our author designates it as the *sulphate of the oxyd of cerotyle*. It appears to be *sulphocerotol* the homologue of sulphomethol, but the equivalent of water which Mr. Brodie obtains in his analysis, makes it an altogether anomalous compound. If we conceive this to be water of crystallization, or to be accounted for by a slight error in the analysis of a body of so high an equivalent, its formula becomes $S\,(C_{27}\,H_{55})_2\,O_4$ or $C_{54}\,H_{110}\,SO_4$ in M. Gerhardt's notation ($=C_{54}\,H_{55}\,O+SO_3$), and it is homologous with sulphomethol.

Cerotol, by the action of chlorine, gives rise to a body which appears to correspond to a chlorinized cerotic aldehyde. By a high temperature cerotol is volatile; it distils in part unchanged and is in part converted into a hydrocarbon and water.

The part of the wax which is rendered soluble by fusion with potash is found to be pure cerotic acid identical with that obtained from bees-wax. By distillation the Chinese wax also yields a portion of cerotic acid in the earlier part of the process, which is separated from the hydrocarbon formed by solution in potash. This consists principally of a solid crystalline substance which resembles paraffine and fuses at about 58° C. Its formula is $C_{27}\,H_{54}$, so that it appears to be a homologue of olefiant gas and cetene; it is called *cerotene*. By the prolonged action of chlorid upon cerotene it yielded successive products, in which analysis showed a progressive substitution of chlorine for the hydrogen; the last gave the formula $C_{27}\,(H_{32}\,Cl_{22})$. An attempt to determine the density of the vapor of cerotene was unsuccessful, and on investigation, Mr. Brodie found, that by repeated distillations, even in a sealed tube, it was converted into a mixture of liquid hydrocarbons of boiling points varying from 75° C. to above 260° C.

The Chinese wax itself appears to be a compound ether homologous with spermaceti; its analysis leads to the formula $C_{54}\,H_{108}\,O_2$; this by the assimilation of $H_2\,O$ is converted into cerotol and cerotic acid $C_{54}\,H_{108}\,O_2+H_2\,O_2\,C_{27}\,H_{56}\,O+C_{27}\,H_{54}\,O_2$. In a third memoir Mr. Brodie proposes to give the results of his investigation of nyricine.

T. S. Hunt.

4. *On Chloropicrine*; by John Stenhouse, PH. D., (Philos. Mag., July, 1848.)—When an aqueous solution of nitropicric acid is poured over an excess of hypochlorite of lime, the mixture heats spontaneously and evolves pungent vapors, and by artificial heat a large amount of a colorless oil distils over with the vapors of water to which the author has given the name of *chloropicrine*. When a clear solution of the hypochlorite is used, a quantity of carbonate of lime separates; a similar decomposition of nitropicric acid is effected by chlorine gas, by mixture of chlorate of potash and hydrochloric acid and by aqua regia, but with the simultaneous production of chloranile. When freed from acid by digestion with carbonate of magnesia, and from water by chlorid of calcium, it is a colorless neutral liquid which boils at 120° C., and has a sp. gr. of 1·6657; its odor is aromatic and when undiluted very pungent, resembling oil of mustard. It is soluble in alcohol and ether,

but nearly insoluble in water, and may be boiled with nitric, muriatic or sulphuric acids without change. By heat it decomposes potassium with violence, but in the cold a mixture of chlorid of potassium and nitre is gradually formed. Watery solutions of alkalies do not affect it, but an alcoholic solution slowly decomposes it, with the separation of nitre and chlorid of potassium. Dry ammonia produces a similar decomposition. By passing its vapor through a tube below a red heat, it is decomposed into chlorine, nitrous oxyd, and a chlorid of carbon, *acetene perchlore* of Gerhardt ($C_2 Cl_6$).

Its analysis gave C 6·30—6·66—6·72. Cl 64·47—64·83. H 0·26—0·22, and a comparison of the volumes of nitrogen and carbonic acid gas from its combustion, gave 1 : 2, making the nitrogen =7·78 per cent., and the oxygen 21·09—21·70; from these Dr. Stenhouse deduces the formula $C_4 Cl_7 N_2 O_{10}$, which accords sufficiently well with analysis but is quite improbable, inasmuch as the sum of the chlorine and nitrogen is not an even number. He rejects the 0·26 of hydrogen as accidental, *but this quantity corresponds exactly to one equivalent* and the formula then becomes $C_4 (HCl_7) N_2 O_{10}$, which is no longer anomalous.

This singular substance requires further examination and deserves to be studied in its metamorphoses by alkalies and reducing agents. It is probable from the large amount of oxygen, as well as from its origin, that the nitrogen is to be viewed as associated with oxygen replacing hydrogen, and the normal compound would then be $C_4 H_{20} O_2$, the formula of chloropicrine being written $C_4 (H_2 Cl_{14} X_4) O_2$.

T. S. H.

5. *On Turpentine Camphor;* by Dr. C. List, (Chem. Gazette, Aug. 1st, 1848, from Jour. für Prakt. Chem., vol. xliii, p. 499.)—This substance is obtained when moist oil of turpentine is exposed to cold, but more abundantly by the process of Wigger, which consists in mixing the oil with alcohol and nitric acid and allowing it to stand for some months. The author adopts for this substance the name of *terpine*, proposed by Berzelius, but for the sake of uniformity, that of *terebol*, proposed by Gerhardt, is preferable. It crystallizes in the trimetric system; the crystals melt with a gentle heat, losing 2 equiv. of water, and are converted into a white opaque mass, which readily absorbs water from the atmosphere, and has the composition $C_{20} H_{20} O_4$. It melts at 217° F., and at a higher temperature sublimes in a current of air condensing in long prisms. Its hot aqueous solution undergoes a singular change by the action of the acids; the liquid becomes milky and acquires a fragrant odor, and by distillation a volatile oil is obtained to which the discoverer has applied the name of *terpinole*. The weakest acids effect this change; one drop of sulphuric acid is sufficient to decompose an ounce of terebol. Terpenole is a colorless oil, having a fragrant odor like hyacinths; it has a sp. gr. of ·852, and boils at 334°. Its formula is $C_{20} H_{17} O$, and it is hence formed from terebol by the loss of the elements of 3 eq. of water.

Terebol absorbs hydrochloric acid gas with the evolution of heat, and water is also probably disengaged. The mass which results on cooling when recrystallized from alcohol, yields large plates which melt at 122° C., have the formula $C_{20} H_{18} Cl_2$, when heated with

water or alcohol they are resolved into terpinol and hydrochloric acid by assimilating one eq. of water. The same compound is directly formed by the action of hydrochloric acid gas on terpinol; it is isomeric with the hydrochloric compound of oil of lemons, but differs from it in its properties. The action of anhydrous phosphoric acid upon terebol removes all the oxygen as water, and yields an oil which is identical in composition with oil of turpentine.

[Dr. List appears to have overlooked the important relations of this substance as one of a series of homologous oils, four of which have been studied. The formula which he proposes should be doubled to accord with the equivalents adopted by the German chemists, and then writing its formula $C_{40} H_{68} O_2$, we have a number of equivalents of hydrogen divisible by 4. But in M. Gerhardt's notation its formula will be $C_{20} H_{34} O$, referring it to the form $R^{-6}O$. We have of this series by the discovery of terpinol at least five known compounds; phenol $C_6 H_6 O$, anisol $C_7 H_8 O$, carvacrol $C_{10} H_{14} O$, cedrol $C_{16} H_{26} O$, and terpinol $C_{20} H_{34} O$, which appear to be homologous. The carbohydrogen which the latter yields by anhydrous phosphoric acid, will be probably $C_{20} H_{32}$, homologous with cerdrene which is formed by the same process from cedrol, and with cinnamene. These homologies point out an interesting field for research in examining the reactions of the last three oils with chlorine, nitric acid and ammonia.]

T. S H.

6. *Improved Method of preserving Milk, patented by* F. H. F. Louis, (Chem. Gaz., Jan., 1849.)—The milk is to be mixed with well clarified raw sugar, 4 oz. to the gallon. It is then to be evaporated with agitation; when nearly solid it must be pressed into cakes of suitable size.

Steam may be used for the evaporation, or if time is no object, spontaneous evaporation in very shallow pans, with the fluid not more than one-tenth of an inch in depth, or a drying chamber may be used, the temperature not to exceed 122° F.

The cakes remain sweet and fresh for a long time and are soluble in warm water. Another process is, to heat the sweetened milk nearly to the boiling point, and before it becomes cold to curdle it by rennet or a weak acid. The curd is separated from the whey, and by strong pressure after washing in cold water, it is obtained free from adhering water. The whey is to be evaporated to dryness. The curd placed over a slow fire is continually stirred, and the dried whey added very gradually, with a small portion of bicarbonate of soda. After a while the ingredients melt and unite. A small quantity of finely pulverized gum-dragon, hastens the solidification.

Cream may be preserved by the same methods.

G. C. Schaeffer.

7. *On a New Method for Amalgamating Zinc;* by Prof. O. N. Stoddard, Miami University, Ohio, (in a letter to one of the Editors.)—This method consists in the employment of double chlorid of zinc and ammonia, (the same solution which is so useful in soldering iron and steel.

The zinc to be amalgamated, is heated to about 450° F. or 500° F., and the liquid applied by a cloth or sponge and the mercury suffered to flow immediately over the surface while still moist.

The union is instantaneous and complete, and the depth of the amalgamation is easily regulated by the quantity of mercury suffered to remain in contact with the zinc.

This method is applicable even when the zinc is thoroughly oxydized on the surface; but if it has been previously used in a galvanic battery, it is best to cleanse the surface first by immersion in somewhat concentrated hydrochloric acid.

A set of Grove's cylinders thus amalgamated, it is stated, have been used at Miami University during a long course of lectures without serious injury and without re-amalgamation.

8. *A Magneto-Tangential Machine*, (in a letter from Prof. O. N. Stoddard.)—The instrument, a description of which is given below, was invented during the winter of 1848, while engaged in a course of lectures upon galvanism, and was intended to exhibit the tangential force of a magnet. As originally constructed, the brass ring within which the spindle revolves, was attached to the top of a wooden cup.

For the present modified form which dispenses with the cup, the writer is indebted to the suggestions of Dr. Locke of Cincinnati.

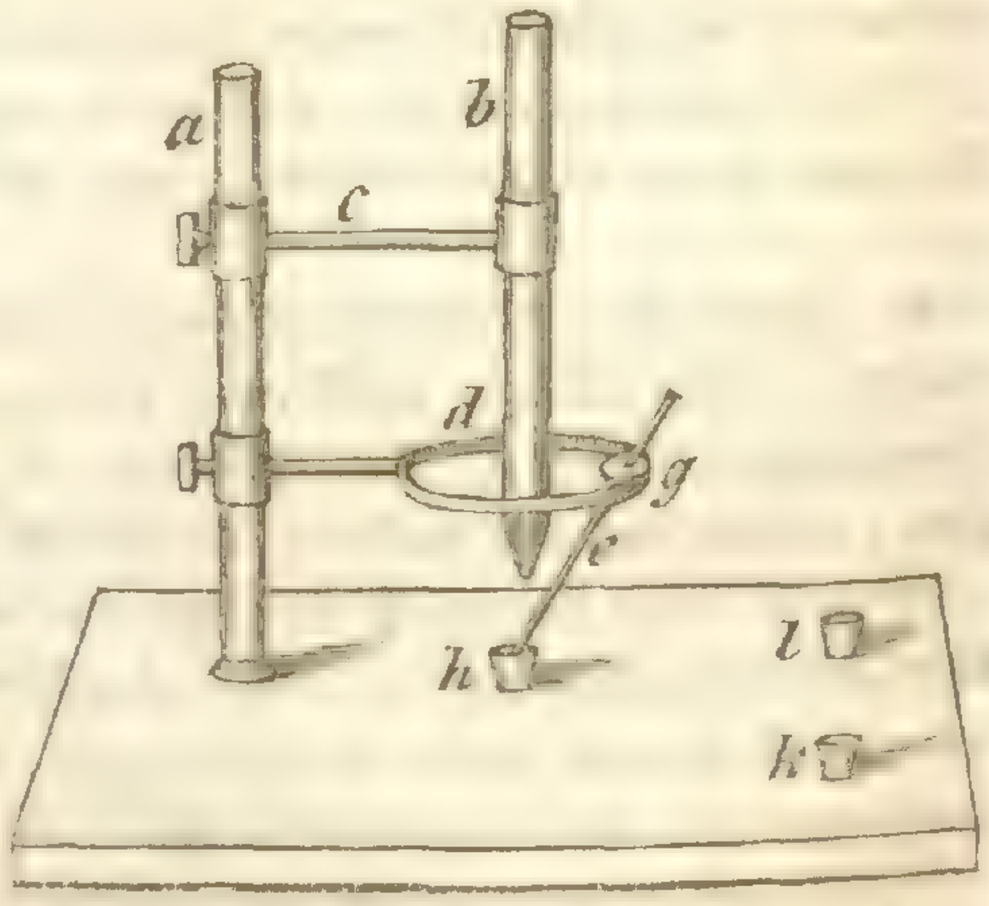
a. An upright pillar or rod of metal.

b. A permanent magnet from 4 to 6 inches in length, and $\frac{3}{4}$ inch in diameter.

c. Arm to support the magnet.

d. A ring of brass attached to the upright, $2\frac{3}{4}$ inches in diameter, and $\frac{1}{2}$ in width, the inner surface beveled, making the lower diameter $\frac{1}{4}$ inch less than the upper.

e. A spindle of copper or brass, 3 inches long and about $\frac{1}{16}$ inch thick, with a circular disk (*g*) of the same metal $\frac{3}{4}$ inch in diameter. The spindle should be carefully turned, and the lower end reduced to a fine point.



h. A cup of brass in which the spindle rests.

l, *k.* Mercury cups, one connected through the upright (*a*) with the ring (*d*), the other with the cup (*h*). As the spindle rests on a fine point, while its disk rolls on the inside of the ring, it revolves with the application of a very slight force.

If one or two drops of mercury be placed in the cup (*h*), a free passage is afforded for the battery current from one mercury cup, through the spindle ring and upright, to the other.

The current is not broken by the revolution of the spindle as its disk is constantly in contact with the ring. On connecting the instrument with a battery, the spindle revolves rapidly around the magnet. With a small battery of copper and zinc, it has made two hundred and fifty revolutions in a minute, and with a few cups of a Grove's battery, more than three hundred.

II. Mineralogy and Geology.

1. *Compact Diamond from Brazil;* by M. Dufrenoy, (L'Institut, No. 792, March 7.)—Specimens of compact diamond have been found in the diamond deposits of Brazil. They have the same relation to the crystals as emery to sapphire. One fragment weighed 65·76 grammes; it had the appearance of a rolled pebble of a brownish color. Under the microscope it appears penetrated by numerous vacuities, separating small irregular lamellæ, slightly translucent, and irised in the sunlight. It cuts glass easily and scratches quartz and topaz. The specimens vary in specific gravity from 3·012 to 3·416, being differently porous. They undergo no change when treated in a crucible, showing that they include no vaporizable material. This result does not prove the igneous origin of these diamonds, but it renders probable the opinion suggested by Liebig, that they proceed from a transformation of vegetable organic matters. By combustion with oxygen they were found to consist of 96·84 to 99·10 of carbon, with 2·03 to 0·27 of ash, the latter being yellowish and appearing like ferruginous clay with some minute transparent crystals whose form was not determined.

2. *Phosphorescence of the Diamond;* by M. Reiss, (Rev. Sci. et Indust., xxiii, 185; Annuaire de Ch., 1847.)—The diamond phosphorescent by exposure to the sun, loses its phosphorescence rapidly when exposed to the red rays; and on the contrary, in the blue rays, it becomes most luminous in the dark.

3. *Examination of three new Mineralogical Species*, proposed by Prof. C. U. Shepard; by J. D. Whitney, (Jour. Bost. Nat. Hist. Soc., 1849, p. 42.)—The species here referred to are the Arkansite, Ozarkite and Schorlomite from Arkansas, described in this Journal, ii ser., vol. ii, 249, and iv, 279.

The *Arkansite*, according to the examinations of Mr. Whitney, is pure titanic acid, with only a trace of iron, (and not a *niobate* as inferred by Prof. Shepard,) and has the crystalline form and specific gravity of *Brookite*. His trials make the specific gravity 4·085. Its insolubility in acids is strong presumptive proof that it is not titanic acid in combination with a base, since all the known titanates are soluble in acids.

The *Schorlomite* was considered by Prof. S. a hydrous silicate of yttria, thorina and oxyd of iron. Mr. Whitney's analyses give the following results:

	I.	II.	III.
Silica, . .	27·89*	25·66	25·14
Oxyd of iron with a little manganese,	21·90	21·58	. .
Lime, . .	30·05	29·78	. .
Titanic acid, . .	20·43=100·27	22·10=99·12	. .

making it an *anhydrous silicate and titanate of lime and oxyd of iron*, having the formula $(\dot{Ca}^3\,\ddot{Si}+\dddot{Fe}\,\ddot{Si})+\dot{Ca}\,\ddot{Ti}^2$, the first part of

* Some of the titanic acid was not separated from the silica.

which is the formula of lime-iron garnet, a mineral with which it is associated. H = 6. G = 3·807. With the fluxes before the blowpipe, it affords beads colored with iron, and with soda a trace of manganese. The salt of phosphorus bead gives in the reducing flame the characteristic color of titanium, which is more distinct on the addition of tin.

Mr. Whitney proposes the new name *ferrotitanite* for the species, on the ground of an error in Prof. Shepard's analysis. But although there may be some reason for the change, the principle involved, if carried out with regard to the names of minerals generally, would create endless confusion in the science.

Ozarkite occurs only as a thin amorphous coating on elæolite. According to Prof. Shepard, it appears to be "a siliceous hydrate of lime and yttria, possibly also having traces of thorina."

Mr. Whitney states that a portion of the mineral as pure as could be separated, fused easily before the blowpipe, intumescing slightly like a zeolite and having a tendency to swell up with vermicular contortions like mesotype or scolecite. It also colored the flame yellow. It readily dissolved in acids to a clear liquid, and a quantitative examination showed it to be a hydrous silicate of alumina and lime, with a little soda, indicating, in connection with other characters, that it is probably a lime-mesotype or *scolecite.*

4. *Chemical Examination of some Minerals*; by J. D. Whitney, (Jour. Bost. Soc. Nat. Hist., 1849, p. 36.)—*Nemalite.*—This mineral is shown by the analysis of Mr. Whitney to be a fibrous variety of the hydrate of magnesia or Brucite. It afforded him magnesia 62·89, protoxyd of iron 4·65, carbonic acid 4·10, water 28·36. A small portion of magnesia is replaced by protoxyd of iron. The formula of Brucite

(Mg $\dot{H}$) requires magnesia 69·67, water 30·33.

Connel's recent analysis* is erroneous from the impurity of his specimen, in including a considerable proportion of carbonate of magnesia.

Coracite of Le Conte.†—An analysis of this mineral afforded:—silica 4·35, alumina 0·90, oxyd of iron 2·24, oxyd of uranium 59·30, oxyd of lead 5·36, lime 14·44, carbonic acid 7·47, water 4·61, magnesia and manganese *in traces* = 98·70. Mr. Whitney considers the uranium in the mineral as $\dddot{U}$ (and not $\dot{U}\,\dddot{U}$ as in common pitchblende) in consequence of its ready solubility in acids. The mineral occurs amorphous, with an uneven fracture and no trace of cleavage. Hardness = 3. Color pitch-black. Powder grey. Lustre resinous. Before the blowpipe it does not change its appearance or color the flame. With the fluxes it gives the characteristic reactions of uranium. In dilute muriatic acid it dissolves readily without heat, effervescing strongly, while pitchblende is insoluble except in nitric acid or aqua regia. The solution has a fine green color and contains a little flocky silica.

Pectolite and Stellite.—Pectolite occurs in Isle Royale, Lake Superior, in spheroidal masses, consisting of delicate silky fibres radiating from a centre, resembling foreign specimens from Monte Baldo. The stellite of Bergen Hill, New Jersey, analyzed by Beck, has the external characters of Pectolite, and also as Mr. Whitney shows, its composition. The following are the results of four analyses:

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* See this Journal, iii, 265, 1847.

† See this Journal, iii, 173, 1847.

	Isle Royal.		Stellite of Bergen Hill.	
	I.	II.	III.	IV.
Silica,	53·45	55·66	54·00	55·00
Lime,	31·21	32·86	32·10	32·53
Soda,	7·37	7·31	8·89	9·72
Potash,	*trace.*	. .	*trace.*	. .
Alumina,	4·94	1·45	1·90	1·10
Water,	2·72	2·72	2·96	2.75
	99·69	100·00	99·85 J.S.K.	101·10 G.J.D.

Analysis III. was made under the direction of Mr. Whitney by Mr. J. S. Kendall, and IV, by Mr. G. J. Dickinson. The formula of von Kobell for pectolite is $3\dot{N}a\,\ddot{S}i + 4\dot{C}a^3\,\ddot{S}i^2 + 3\dot{H}$.*

The Stellite of Thomson, Mr. Whitney observes, was probably impure Pectolite; and he refers Thomson's Wollastonite to the same species.

5. *On the Constitution of some Silicates containing Carbonic Acid, Chlorine and Sulphuric acid;* by J. D. Whitney, (Pogg. Ann. der Ph. und Ch., lxx, 431.)—Mr. Whitney in this paper gives the results of his examinations of the Sodalite and Cancrinite of Litchfield, Maine,† besides analyses of Nosean or Spinellane, Haüyne and Ittnerite.

The *Sodalite* occurs with elæolite in small cleavable masses of a sapphire blue color. The analyses afforded,

	I.	II.	Calculated.
Silica,	37·30	37·63	37·60
Alumina,	32·88	30·93	31·57
Peroxyd of iron,		1·08	
Soda,	23·86	25·48	25·47
Potash,	0·59	. .	. .
Chlorine,	6·97	. .	7·21

whence we have the formula, deduced by von Kobell,

$$\dot{N}a^3\,\ddot{S}i + 3\ddot{A}l\,\ddot{S}i + Na\,Cl.$$

The *Nosean* of Laacher See was found to contain:—Silica 36·52, alumina 29·54, peroxyd iron 0·44, lime 1·09, soda 23·12, chlorine 0·61, loss by heating 1·37, sulphuric acid 7·66; giving the formula,

$$\dot{N}a^3\,\ddot{S}i + 3\ddot{A}l\,\ddot{S}i + \dot{N}a\,\ddot{S}.$$

For the *Haüyne* from Albaner-gebirge, Mr. Whitney obtained:—Silica 32·44, alumina with a little water 27·75, lime 9·96, soda 14·24, potash 2·40, sulphuric acid 12·98=99·77. Formula,

$$\dot{N}a^3\,\ddot{S}i + 3\ddot{A}l\,\ddot{S}i + 2\dot{C}a\,\ddot{S}.$$

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* Mr. Whitney's researches confirm the opinion of the identity of these minerals, suggested in my System of Mineralogy, p. 356. Mr. A. A. Hayes, in his analysis of the Bergen mineral, there quoted, obtained for its composition, Silica 55·96, lime 35·12, soda 6·75, potash 0·60, alumina and magnesia 0·08, protoxyd of manganese 0·64, water (hygrometric) 0·16=99·31. Frankenheim had stated that Pectolite contained no water; but Mr. Whitney's analyses confirm the results of von Kobell. —J. D. D.

† This Journal, 2d Ser., i, 119, 1846.

The mineral occurs in small druses with vesuvian, and has a clear greenish-blue color.

The Hauyne from Niedermendig afforded in one of his analyses, Silica 33·90, alumina 28·07, lime 7·50, soda 19·28, sulphuric acid 12·01 =100·76, with a trace of chlorine. No simple formula can be deduced from this result; but it corresponds quite well to a compound of 2 atoms of Hauyne and 1 of Nosean.

The *Cancrinite* occurs in hexagonal prisms, with lateral cleavage, and in columnar masses. The crystals have the hardness 5·5–6, specific gravity 2·448, and a citron or sulphur yellow color; the lustre inclines to greasy, except on a cleavage face which is vitreous. Transparent to translucent. Heated in a glass tube it gives off water and loses color immediately. In the forceps it fuses easily with effervescence to a colorless transparent blebby glass. With soda it effervesces and forms an opaque pearl, colored by manganese. With borax it forms freely a clear colorless glass. With salt of phosphorus it affords a clear pearl which becomes milky on cooling. With cobalt solution it gives a fine blue. The first of the three analyses, (which well agree,) afforded :—Silica 37·42, alumina 27·70, *peroxyd of manganese* 0·86, *peroxyd of iron a trace*, lime 3·91, soda 20·98, potash 0·67, chlorine *a trace*, carbonic acid and water 8·77=100·41. Including the water as an essential ingredient, Mr. Whitney deduces the formula,

$$\dot{Na}^2\,\dddot{Si} + 2\dddot{Al}\,\dddot{Si} + (\dot{Na}^{\frac{1}{2}} + \dot{Ca}^{\frac{1}{2}})\,\ddot{C} + \dot{H}.$$

The formula of foreign Cancrinite is $\dot{Na}^2\,\dddot{Si} + 2\,\dddot{Al}\,\dddot{Si} + \dot{Ca}\,\ddot{C}$, and that of Stroganowite, (Hermann,) another silicate containing a carbonate, $(\dot{Na}^2, \dot{Ca}^2)\,\dddot{Si} + 2\dddot{Al}\,\dddot{Si} + \dot{Ca}\,\ddot{C}$.

6. *Mineral Coal on the Nile*, (A. d'Abbadie in Athenæum, No. 1111, Feb. 10.)—Coal is reported to have been found on the banks of the Nile, near Asuan. The first vein, six feet thick, is one hundred feet below the surface. Still deeper is a second bed of only three feet thick, but of excellent quality.

7. *Mineral Coal of Vancouver's Island, North West America*, (Athenæum, No. 1110, Feb. 3.)—The Port of Camosack with its excellent harbor, promises to become of great importance, especially on account of the coal field of the northeastern district. The coal is worked so near the surface, that the Cormorant, steam sloop, was supplied by the natives with sixty-two tons of coal within three days. Specimens of this coal have been examined by the Admiralty; and although it yields a considerable percentage of ash, it is not much inferior to the coal of South Wales.

8. *Gold of Africa.*—According to St. Petersburgh papers, Col. Kavelooski, Director of the Mines of Siberia, at present engaged in a Mineralogical exploration of the interior of Africa, has found on the right bank of the Somat, a day's journey from Cassen, several large hills of auriferous sand, the washing of which is more productive than that of those of Siberia. Stimulated by this discovery, he pursued his examinations, and discovered similar tracks on the banks of the

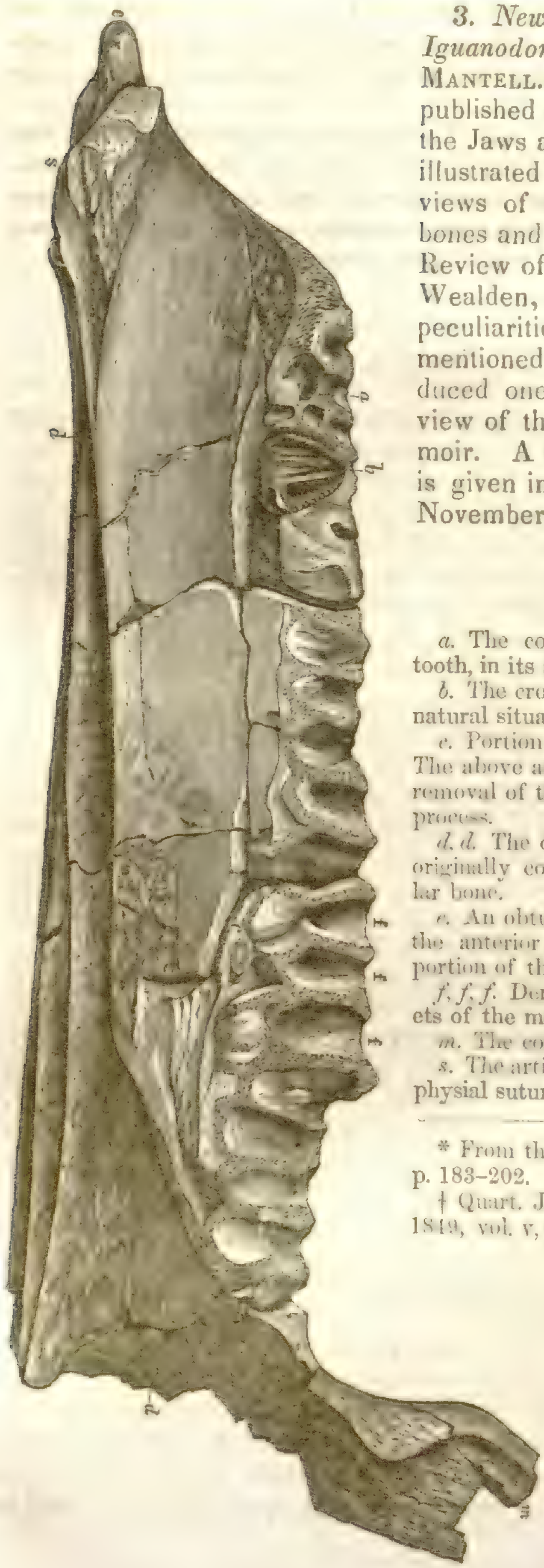
Ramla, the Dys, the Goucka, the Benisch-Angol, and the Gamanil. It is stated that the Colonel was about to transport miners and gold-washers from Russia, to experiment in this field of his discovery on a large scale.—(*Athenæum.*)

9. *Vesuvius.*—In January last Vesuvius was singularly active, and two large streams of lava issued forth, taking the direction of Boscotrecase and Ottaiajano. After causing much fear and injury, the vents closed; but near the last of the month another stream burst out, down the east side, and threatened the villa of Prince Ottaiajano.

III. Zoology.

1. *New localities of Infusoria in the Tertiary of Maryland;* by Prof. J. W. Bailey.—The infusorial strata first discovered at Richmond, Virginia by Prof. W. B. Rogers, have been since noticed at so many places in Virginia and Maryland, that it is probable they will be found coextensive with the miocene tertiary of the United States. At present, however, the most southern *recorded* locality is the vicinity of Petersburg, Va., and the most northern is at Piscataway, Md. The examination of various specimens of earthy matter included in shells from the miocene tertiary of Maryland, collected by Francis Markoe, Esq., proves the existence of the infusorial strata in various parts of Calvert county, and removes the northern and eastern limit as far as now known, to Herring Bay, Ann Arundel county, on the Chesapeake. Specimens labelled "Marl from Herring Bay filled with water-worn shells, bones, sharks' teeth, &c.," yielded a considerable number of the well known Coscinodisci, Actinocycli, and other forms, constituting so large a proportion of the infusorial deposits. The same forms were found in considerable abundance in the clay containing Perna maxillata, from the vicinity of Huntington, Calvert county, Md., and other specimens labelled "Calvert Co." without mentioning the precise locality, were still richer in all the beautiful forms which belong to the deposit at Piscataway, Md. The infusorial strata being thus traced up to the western shore of the Chesapeake, they must now be looked for among the tertiary clays of Queen Anne county, Maryland, and Kent county, Delaware. A wide development of these beds is to be looked for in the Southern States, particularly in North and South Carolina, but no infusorial specimens from those states have yet reached us. The Polythalamian marls underlying the city of Charleston, South Carolina, are sometimes spoken of as infusorial, but they appear to be wholly made up of the calcareous shelled Polythalamiæ, without a trace of the siliceous shells of the infusoria.

2. *The Oyster.*—M. de Quatrefages has recently ascertained that, contrary to the common opinion, the sexes are separate in the oysters. M. Blanchard's observations confirm those of M. de Quatrefages. In his investigations into the nervous system of Mollusca, he has had occasion to examine a great number of these animals, and in the proper season, he has always found the eggs and the spermatozoa isolated in different individuals.



3. *New Discoveries of Bones of the Iguanodon*; by GIDEON ALGERNON MANTELL.—Dr. Mantell has recently published a Memoir on the structure of the Jaws and Teeth of the Iguanodon, illustrated by four large plates, giving views of the newly discovered jaw bones and of the teeth;*—and also a Review of the Organic Remains of the Wealden, in which the more striking peculiarities of these fossil bones are mentioned.* We here give a copy (reduced one-third lineally) of an inner view of the jaw from the former memoir. A full abstract of this memoir is given in vol. vi, p. 430, No. 18, for November, 1848.

EXPLANATION.

a. The coronal germ of the first anterior tooth, in its alveolus.

b. The crown of a successional tooth in its natural situation.

c. Portion of the base of a successional tooth. The above are visible in consequence of the removal of the inner parapet of the alveolar process.

d, d. The deep elongated *opercular furrow*, originally covered by the splenial or opercular bone.

e. An obtuse tubercle or projection forming the anterior termination of the symphysial portion of the jaw.

f, f, f. Denote some of the alveoli or sockets of the mature molar teeth.

m. The coronoid or complementary bone.

s. The articulating surface forming the symphysial suture.

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* From the Phil Trans. for 1848. Part II, p. 183–202.

† Quart. Jour. Geol. Soc., No. 17, Feb. 1, 1849, vol. v, p. 37.

4. *Additional Observations on the Osteology of the Iguanodon and Hylæosaurus;* by GIDEON ALGERNON MANTELL, Esq., L.L.D., F.R.S., Vice President of the Geological Society of London, &c., (Proceedings of the Royal Society, March, 1849. The Marquis of Northampton in the chair.)—This memoir, which is supplementary to the author's former communications to the Royal Society on the same subject, comprises an account of some important additions which he has lately made to his previous knowledge of the osteological structure of the colossal reptiles of the Wealden strata of the southeast of England.

The recent acquisition of some gigantic and well preserved vertebræ and bones of the extremities from the Isle of Wight, and of other instructive specimens from Sussex and Surrey, induced the author to resume his examination of the detached parts of the skeleton of the Wealden reptiles in the British Museum and in several private collections; and he states as the most important result of his investigations, the determination of the structure of the *vertebral column*, *pectoral arch*, and *anterior extremity* of the Iguanodon. In the laborious and difficult task of examining and comparing the numerous detached and in most instances mutilated bones of the spinal column, the author expresses his deep obligations to Dr. G. A. Melville,* whose careful and elaborate description of the vertebræ forms an appendix to the memoir. The most interesting fossil remains figured and described, are the following:—

Lower Jaw.—Since the author's memoir on the maxillary and dental organs of the Iguanodon,† he has discovered the right *ungular* bone; and from the circumstances under which this relic was found, he considers it probable that it belonged to the same individual as the teeth figured in the Philos. Transactions, for 1848.

Vertebral column.—The vertebræ hitherto assigned to the Iguanodon, consist of the middle and posterior dorsal and anterior caudal, as established by the Maidstone specimen in the British Museum; the cervical, anterior dorsal, lumbar, and posterior and terminal caudal, were previously either undetermined, or referred to other and distinct genera of saurians. The investigations of Dr. Melville and the author, have established the important and highly interesting fact, that the cervical and anterior dorsal vertebræ of the Iguanodon were *convexo-concave*—that is, convex in front and concave behind, as in the fossil genus termed *Streptospondylus*, and in the existing pachyderms. The convexity gradually diminishes and the anterior face of the vertebræ becomes flat in the middle and posterior part of the dorsal region. The supposed Streptospondylian vertebræ of the Wealden, referred by Professor Owen to a new species (*Strep. major*), are true cervical vertebræ of the Iguanodon. The convexo-concave type of vertebræ was not, in the opinion of the author, confined to a single genus—the Streptospondylus of the oolite—but was present in two, and probably in several genera of extinct saurians of the secondary geological epochs, in like manner as the reverse forms—the concavo-convex—prevail in the recent

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* One of the authors of the Work on the Dodo, reviewed in this volume, p. 52.

† See preceding page.

Crocodilians and Lacertæ. Other large vertebræ found with bones of the extremities, ribs, &c., of the Iguanodon, and referred by Professor Owen to the genus *Cetiosaurus*, are regarded, in consequence of the peculiar structure of the neural arch, as belonging to the posterior dorsal or lumbar vertebræ of the former colossal reptile. Certain angular caudal vertebræ, also previously assigned to a species of Cetiosaurus, are considered by the authors as referable to the middle and distal regions of the tail of the enormous saurian, with whose bones of the extremities they are constantly found associated.

The Sacrum.—Several examples belonging to individuals of various sizes and age, are described. The sacrum is shown to consist of *six* anchylosed vertebræ, and not of *five* only, as stated by Professor Owen; and the typical specimen described by the latter eminent anatomist, was exhibited by Dr. Mantell in proof of this assertion. The anterior vertebra, and the two posterior vertebræ are much longer and stronger than the three intermediate elements that occupy the centre of the sacral arch.

Pectoral arch.—A perfect *scapula* or *omoplate* of the crocodilian type recently discovered in Tilgate Forest, and which corresponds with a coracoid bone formerly referred by the author to the Iguanodon, (Philos. Trans., 1841), is proved to belong to that reptile, from the remains of two similar scapulæ in the Maidstone specimen in the British Museum.* As the clavicals were already known, the essential elements of the pectoral arch of the Iguanodon are now for the first time ascertained; and the author gives a restored figure of this important part of the skeleton.

The Humerus or arm-bone.—A humerus three feet long, found in the Isle of Wight, has been ascertained by Dr. Mantell to belong to the Iguanodon, from its entire correspondence with a bone in the Maidstone fossil, previously undetermined. This last bone, from its disparity in size in comparison with the femur—being one-third shorter—was formerly assigned to the fore-arm, but the fossil from the Isle of Wight enabled the author to ascertain its true place in the skeleton. It now appears that in the Iguanodon, as in many fossil and recent reptiles, the anterior extremities were shorter and less bulky than the posterior. The *radius* and *ulna* are still unknown, but the author conceives that certain imperfect bones in his former collection (now in the British Museum), are those of the fore-arm.

Hinder extremities.—The colossal magnitude of the Iguanodon is strikingly shown by some thigh and leg-bones recently discovered in the Isle of Wight. A *femur* or thigh bone is four feet eight inches long; and a *tibia* or leg-bone four feet long.

Dermal scutes and Spines.—The author figures and describes several dermal scutes and spines, and states that a microscopical examination of the large angular bones of the Hylæosaurus† supposed by him to be ossified dermal spines, but which Professor Owen regarded as more probably referable to the abdominal ribs, proves the correctness of his own opinion, for their structure is identical with that of the indisputable dermal scutes.

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* Figured in Dr. Mantell's Wonders of Geology.

† See a figure in Dr. Mantell's Medals of Creation.

In the summary which concludes this important memoir, Dr. Mantell states that the parts described confirm in every essential feature the physiological inferences relating to the structures and habits of the Iguanodon and Hylæosaurus enumerated in his former communications; and thus after the lapse of a quarter of a century he concludes his attempts to reconstruct the skeleton of one of the most extraordinary Saurian herbivores that has trod the dry land of our planet, and of whose former existence a few waterworn teeth and bones were the only indications, when in 1825 he laid before the Royal Society the first notice of a newly discovered herbivorous reptile from the strata of Tilgate Forest.

The memoir was illustrated by numerous drawings and diagrams, and the table of the library of the Royal Society was covered with the unique and highly interesting fossils described in the communication.

5. *Fossil Squalidæ of the United States*; by R. W. Gibbes, M.D., (Jour. Acad. Nat. Sci. Philad., July, 1848, and Jan., 1849.)—These two valuable memoirs by Dr. Gibbes, are very fully illustrated by excellent lithographic quarto plates, (the first by four, and the second by three,) including in all, nearly two hundred figures. The collections of the author are peculiarly rich in the teeth of the Squalidæ from the tertiary beds of South Carolina.

The following is a list of the species and varieties described and figured;—for the descriptions we must refer to the memoirs themselves.

1. *Teeth with crenated edges.*

Genus Carcharodon. C. megalodon (*Agas.*), *var.* rectidens, and subauriculatus; angustidens (*Ag.*), *var.* lanceolatus, heterodon, megalotis, ariculatus, turgidus, semiserratus, toliapicus, acutidens, Mortoni, lanciformis, sulcidens.

Genus Galeocerdo. G. aduncus (*Ag.*), latidens (*Ag.*), minor (*Ag.*), Egertoni (*Ag.*), pristodontus (*Ag.*), contortus (*Gibbes*).

Genus Hemipristis. H. serra (*Ag.*)

Genus Glyphis. G. subulata (*Gibbes.*)

Genus Sphyrna. S. prisca (*Ag.*), lata (*Ag.*), denticulata (*Ag.*)

Genus Notidanus. N. primigenius (*Ag.*)

2. *Teeth with smooth edges.*

Genus Lamna. L. elegans (*Ag.*), cuspidata (*Ag.*), compressa (*Ag.*), acuminata (*Ag.*), crassidens (*Ag.*), contortidens (*Ag.*), Hopei (*Ag.*), verticalis (*Ag.*), gracilis (*Ag.*)

Genus Otodus. O. obliquus (*Ag.*), appendiculatus (*Ag.*), levis (*Gibbes*), crassus (*Ag.*), macrotus (*Ag.*), trigonatus (*Ag.*), apiculatus (*Ag.*)

Genus Oxyrhina. O. hastalis (*Ag.*), xiphodon (*Ag.*), plicatilis (*Ag.*), Mantelli (*Ag.*), crassa (*Ag.*), minuta (*Ag.*), Sillimani (*Gibbes*), Desorii (*Gibbes*), Wilsonii (*Gibbes.*)

The monograph is to be continued from time to time as specimens are procured.

IV. Astronomy.

1. *Le Verrier's Further Vindication of his predicted theory of Neptune.*—In my communication of the 11th of September last, I showed that the differences between the predicted elements of Neptune, and those which result from observation are inconsiderable. I now propose to go farther into the question, and to prove that all these differences are within the limits which the uncertainty of the data will allow. The discussion will thus terminate with those who seek only for the light. They will reflect, that when an author has brought forth from the data of a question all that is therein contained, nothing more can be asked of him; and that the more uncertain the data, the more difficult is it to bring out the truth.

It will be impossible for me to give, in this recapitulation, more than the results of the calculations which served me a basis. These calculations being very extended, I ought simply to lay them before you as matters of demonstration. But nothing would be more agreeable to me than to give conscientiously to each, all the scientific explanations conscientiously asked.

I. I take up first, the comparison of the true longitude of Neptune, as deduced from my theory, with that which results from the orbit calculated by Mr. Walker, from the position of 1795, and upon the observations made during the two last years. This comparison furnishes:

	True longitude in the predicted orbit.	True longitude in the orbit of Walker.	Difference.
In 1887 . .	396°·9	415°·5	18°·6
1877 . .	380 ·9	393 ·6	12 ·7
1867 . .	363 ·9	371 ·6	7 ·7
1857 . .	345 ·7	349 ·7	4 ·0
1847 . .	326 ·5	327 ·5	1 ·0
1837 . .	306 ·4	305 ·7	− 0 ·7
1827 . .	285 ·9	283 ·9	− 2 ·0
1817 . .	265 ·3	262 ·2	− 3 ·1
1807 . .	245 ·2	240 ·7	− 4 ·5
1797 . .	225 ·9	219 ·3	− 6 ·6
1787 . .	207 ·6	198 ·0	− 9 ·6
1777 . .	190 ·4	176 ·7	−13 ·7
1767 . .	174 ·3	155 ·5	−18 ·8

The question is, are these differences, thus *rigorously* calculated for 120 years, practically less than those which the *uncertainty of the data* would and ought to introduce, at one epoch or another.

First of all, let us understand well, the signification of this expression, *uncertainty of the data;* an expression which has too often, through misapprehension, been taken for *uncertainty of the observations.* If any one will read the 239th page of the memoir published in 1846, he will see that such a substitution of terms was not allowable.

I will here explain, that the *uncertainty of the data*, results not only from the *uncertainty of the observations*, but also from two other causes, viz: 1st, from the possible inaccuracy in the mass of Saturn which may increase the uncertainty of observation 3″: and second, from the influence of a planet situated beyond Neptune, whose effect on Uranus,

it is easy to see, would amount to from 5″ to 7″. Combining the possible effects of these three causes, there results, as I have already explained, in 1846, the *uncertainty of the data.* It may fully amount to 10″ or 12″, although the *uncertainty* of modern *observations* is not greater than 2″ or 3″.

And after having added, in the same memoir, that the magnitude of the discrepancies which might be allowed between observation and calculation, is thus indeterminate, I fixed it arbitrarily at 5″ for all the positions of Uranus observed from 1781 to 1845. It is on this *arbitrary* hypothesis that I have made my calculations of limits. But it will be seen, and should not be forgotten, that instead of 5″, I could have taken 10″ and even 12″.

All this being granted, if any one will completely develope the numerical calculations of my theory of limits, a brief synopsis of which I have given in the memoir of 1846, it will be found, *even reducing the uncertainty of the modern data to* 5″, that during 120 years which I have compared as above, the differences of the longitudes of Neptune in my predicted orbit and in the orbit of Walker, are always within the uncertainty of the data. It is the same whether before or after these 120 years. But I confine myself to the consideration of this period —sufficiently long however—because I can, in regard to it, support myself upon the *Compte Rendu* of the 31st of August, 1846, and upon my complete memoir published in the *Connaissance des Temps.*

I showed, the 31st of August, 1846, before the discovery of Neptune, that it might be necessary to push the search 18°·5 beyond the position which I had assigned as the most probable. I printed it anew after the discovery of the body.

Thus, since 1846, I have acknowledged that the uncertainty of the data might cause an uncertainty of more than 18 degrees in the place of the planet, at one of the epochs when we could best answer for its position. It is evident that the discordance in the longitude calculated by my theory, has never been, during 120 years, equal to that which I considered in 1846 as possible. Upon which I ought to remark:

1st. It is proved that, whether before the discovery of Neptune, or after that discovery in 1846, or at the present day, I have always held the same language relative to the uncertainties in the results, produced by the uncertainty of the data.

2d. The orbit calculated by Mr. Walker upon the position taken in 1795, and upon the whole of the small arc observed since the discovery, may very possibly be in error many degrees, either in 1887 or 1757; and that, if I have admitted as exact, the positions which it furnishes at these epochs, it was only through courtesy, and because it was no embarrassment to me.

3d. Although the discordance of my theory might be 18°·5, in 1846, without furnishing occasion for complaint, yet the real discordance is found to be much less, and has never exceeded 3°·7 during the period in which the perturbations were sensible. This is a point upon which I insist in a very particular manner, and I pray that it may receive some attention.

II. I shall be brief upon the distance from the sun, because it is virtually comprised in the elements of the ellipse, which I shall consider

in detail. My orbit gives 33·0 for the distance of Neptune from the sun at the time of discovery.

The orbit of Walker gives 30·1 for the distance from the sun at the same period.

Now in reducing to numbers my theory of limits, I find, *without supposing the uncertainty of the modern data greater than* 5″, that the theory of Uranus would be satisfied, if a planet were situated at any distance from the sun comprised between the limits 29·6 and 35·2. The two numbers above mentioned are really contained between these limits.

I pass to the elements of the ellipse themselves, elements which I did not directly consider in my first discussion, but in which they are found to be virtually contained. The elements, I have said to the Academy, are only mathematical *auxiliaries*, suited to lead to the knowledge of the direction and distance; these auxiliaries might vary considerably, without failing to give the position of the disturbing body at the epochs of the perturbations.

I did not then know that foreign astronomers would be so ready to send me declarations conforming to those of my illustrious brethren, Messrs. Biot, Cauchy and Faye; and that among these testimonies would be found a thorough discussion of the question, signed *Herschel;* a discussion superior to any that could emanate from my pen, and whose publication would have been my only defense, had I then possessed it, and if even at the present time I am not in haste to reveal it to the friends of science, they will not reproach me when I inform them that this illustrious English Astronomer is engaged in putting in a clear light all the scientific points of this discussion with the intention of soon publishing the result of his researches.

I give meanwhile the following extract from the letter of Herschel.

"The elements are *intellectual objects*, suited to represent to the mind the general relations of the planet with time and space, while the direct object of your efforts was to say where the disturbing body was placed at the epoch of the research, and where it was during the forty or fifty years preceding. Now it is this which you have made known with perfect accuracy."

These remarks being made let us consider the elements.

III. *Longitude of the perihelion.*—I assigned 284°·8 for the longitude of the perihelion of Neptune.

Mr. Walker gives 360°·2 for the longitude at the same epoch. The difference, 75°·4, it is said, is enormous, and without doubt it is. But the question is, to know if the uncertainty of the data authorizes this difference.

In reducing to numbers my theory of limits, *without carrying the uncertainty of the modern data beyond* 5″, I find that the perihelion may be placed at any distance between 229°·9 and 366°·4.

The numbers 284·8 and 360·2 are both within these limits.

IV. *Mean Longitude.*—This element is variable with the time. Whatever may be the epoch to which it is referred, the same results will necessarily follow. Let us take the epoch of January 1st, 1847.

I have given in my memoir 318°·8 for the mean longitude.

Mr. Walker finds 328°·1.

My method assigns for the limits of this element 310°·5 and 335°·6, always taking but 5″ for the uncertainty of the modern data.

The number of Mr. Walker, and my own, are within these limits.

V. *Eccentricity.*—I have given 0·1076 as the value of this element, whilst that of Mr. Walker is only 0·0088.

The discordance may appear considerable to those who know not how ill determined are the eccentricity and major axis of an ellipse from even a considerable portion of the curve known, as will be seen in the two ellipses of *gamma* Virginis. But all embarrassment vanishes when we take the trouble to calculate the limits of uncertainty of the eccentricity, corresponding to the limits of uncertainty of the data.

It is actually found, in admitting only 5″ of uncertainty, *in the modern data*, that the eccentricity of the body causing the irregularities of Uranus may be arbitrarily chosen between 0·2031 and 0·0592; limits already much extended, and which explain why the eccentricity of Neptune was determined so poorly, by its action on Uranus. But more, we have only to carry the uncertainty of the modern data to 7″ or 8″ as may properly be done, to see that the inferior limit of eccentricity falls nearly to zero, and the superior limit is raised to 0·25, or even higher. Thus the eccentricities given by my theory and by the orbit of Mr. Walker come completely within those which are authorized by the uncertainty of the modern data.

The eccentricity, I repeat, is but a mathematical *auxiliary*; and it is not by such auxiliaries that the degree of precision of a theory must be judged. They may vary very much, as we see, without the final result, which is here the longitude, experiencing any remarkable variations. I have often had occasion to show the Academy, how changes, almost insignificant, in the positions (deduced from direct observations) which have served to determine the elements of a comet or planet, have produced considerable changes in the values of the elements.

By fitly choosing the auxiliaries, and comparing them without knowing their signification, we could, *in appearance*, spoil any theory whatever. What an enormous discordance there seems, at first sight, between two theories in which the tangents of the same angle are represented by the numbers 206265 and 344. And yet on referring to the angles themselves, that is to say, to the direct object of the question, it will be found that they differ but *ten minutes.*

VI. *Semi-axis major.*—The semi-axis major gives occasion for the same remarks as the eccentricity. There has been thought to be an insurmountable difficulty, in what I have said, (page 240 of the memoir of 1846,) viz., that the semi-axis major was contained between the limits 37·90 and 35·04, while Mr. Walker makes it 30·20.

I do not believe, to tell the truth, that the direct observations of Neptune, which we have at the two ends of an arc one hundred degrees in length, are sufficient for a good determination of the semi-axis major of the orbit. But I have said that I will not contest this point.

The solution of the pretended difficulty lies wholly in the fact, that the limits 37·90 and 35·04 *are not absolute limits*, but limits relative to the *arbitrary* hypothesis that the modern data do not allow of a greater uncertainty than 5″. It will not be forgotten that I explained on the

239th page of the memoir already cited, that this uncertainty might be much greater, and amount even to 10″ or 12″, *as is the case in the tables of Saturn and Jupiter*, and as I have exhibited above.

When we re-calculate the limits of the semi-axis major with other uncertainties than 5″ in the data, we see that it is a great error to suppose the extent of the limits of the semi-axis major varies proportionally to the uncertainty of the data. It varies much more rapidly. Thus, although for 5″ of uncertainty in the data we find an interval of 2·86 between the limits of the semi-axis major, this interval so diminishes with the uncertainty of the data, that when we reduce it to one half, we find no value of the semi-axis major whatever that can satisfy the question. And on the contrary when we carry the uncertainty of the modern data above 5″ we see that the lower and higher limits of the major axis change rapidly, and leave a great latitude in the choice of this auxiliary. "Without doubt," says Sir J. Herschel, "we may take for the starting point any value for the semi-axis major comprised between 30 and 38." It is not necessary to consider the period of revolution separately, since it depends solely on the semi-axis major. But it is proper to consider here another difficulty which has been supposed to exist in the fact, that with the semi-axis major 30·20 the period of revolution of Neptune should be very nearly double that of Uranus; a circumstance which would introduce in the theories of these two planets, irregularities of considerable magnitude. *It is a difficulty only of form*, says Sir J. Herschel with propriety, in his letter. And in fact so far from these great irregularities being an embarrassment, we may neglect them for a period of time equal to that which I have considered. I have given the reason on page 157 of my memoir. In the inequalities of the form A sin $(\alpha t + \beta)$, α is a very small angle, so that in the limits wherein the time is comprised, we may substitute sin $(\alpha t + \beta)$ for a progressive convergent series, according to the powers of the times, and limited to the two first terms. Now these terms are confounded with the mean longitude of the elliptical part of the movement of the disturbed body, and may therefore be neglected in the calculation of the perturbations.

It is a serious error to suppose that the *absolute values of the perturbations*, at a given epoch, can serve to determine the position of the troubling body which produces them. We can only make use of the variations which these perturbations experience, with the times, and yet, must reject the part proportional to the times. The analytical formulæ which we employ to represent the position of the troubling body, ought to satisfy only the condition of furnishing, during the interval of time in which the perturbations are sensible, the same second differences of the perturbations, that are obtained by quadratures, when we know beforehand the geometrical situations of the disturbing body and its mass.

VII. *Mass.*—The mass of Neptune deduced from the observation of its satellite is, according to Mr. Struve, 0·65 of the mass which results from my theory; the extremest valuations reduce this down to 0·52 of this mass.

Now my theory of limits shows that an uncertainty of only 5″ in the modern data, allows of the adoption of a mass *more than twice* as

great as the one I have given, as also a mass which may be but 0·63 of the same. And in order to have a mass but half of that which I have given, we need only to carry the uncertainty of the modern data to 7″·4. This therefore presents no difficulty.

To recapitulate :—

I announced in 1846, that on a given day, might be found in a given place, a planet that would account for the perturbations of Uranus. And the astronomers of Berlin found on the day, and in the place indicated, a planet which does account for the perturbations of Uranus.

This coincidence was not accidental. Suppose I were to-day, Oct. 2d, 1848, to make known to the Academy, for the first time, my work, and having deduced the place where we ought to look for the planet this evening, we should immediately discover the body, at a distance less than *a degree and a half* from the position we would have thus assigned it. The prediction would have been equally exact in 1837 or 1827. At any epoch an observer would have found the planet within the limits which my calculation assigned it; and during 120 years these limits have not exceeded those which I gave even in 1846; limits which were printed before the discovery, in our *Comptes Rendus*, and after the discovery of the body in the *Connaissance des Temps.*

It results in short, from my theory of limits, the exposition of which I have given on pages 239–249 of the memoir of 1846, that the elements of Neptune deduced from observation, do not differ from the predicted elements more than the uncertainty of the data authorizes. **The proof is unanswerable.**

Among the periodical comets recently discovered, there is not perhaps one, the theory of which, founded upon actual observations made during one appearance, would give, after sixty years, the longitude with as much certainty and precision as I have obtained.

Allow me to speak with freedom. When I announced my principal result in 1846, I found scarcely a person who would believe it. Deduce the position of a planet from a little derangement which it caused in Uranus! What folly! it was said. But those who spoke thus, are precisely the ones, who, at the present day, find it altogether intolerable, that I have not succeeded in giving the position of Neptune for eighty years, without an error of more than 7½° at the end of this period, and who think the world ought to make a severe example of me.—*Comptes Rendus Acad. Sci., Paris, October 2d*, 1848.

2. *Indication of a Method of testing Olbers's Theory respecting the common origin of the small Planets;* by S. Alexander, (from Nos. 658 and 659, of the Astronomische Nachrichten; communicated for this Journal by the author.)—Since the discovery of so many new planets in the region between Mars and Jupiter, the hypothesis of Olbers with respect to their origin has, of course, received renewed attention. Any thing which may have a tendency to confirm or to refute that hypothesis cannot fail to be of interest. I would therefore respectfully propose a mode of investigation which, if successful, might afford a plausible confirmation of the hypothesis of the explosion of a single planet in the region in question, or else show, with an equal plausibility, **that no such event could have occurred.**

The computation of the paths of the fragments, immediately subsequent to the rupture, must, at present, be regarded as beyond the reach of analysis; but the mass of the planet being small, the mutual perturbations of its fragments must soon have been quite inconsiderable. When this state of things was attained, the nodes of the orbits then to be described may yet have been very nearly together; viz., the nodes of the orbits of the several fragments as marked upon the orbit of the original planet, or the nodes of all the fragments but one, as marked upon the orbit of that excepted one. At the same time the respective distances of the several fragments from the sun must all have been very nearly equal.

It becomes us then to inquire, how nearly the data which we at present possess, or may yet acquire, will enable us, by computation backward, to arrive at an indication of this state of things.

Now the masses being all insignificant, it would seem that the *secular motions* of the nodes of the several orbits upon the ecliptic (or that of the nodes of all the orbits but one counted upon the orbit of that excepted one) as well as the motions of the lines of apsides, might all be very accurately determined.

Should the algebraical differences of the motions of the nodes, thus found, indicate a near approach of all the nodes at some former period, this would itself be an indication of the common origin of the planets in question; and the time at which the nearest approach was found to have occurred, would also be the latest date which could be assigned to the rupture of the original planet.

All this would be confirmed, if the secular motions of the major axes of the several orbits should also indicate such a position of them, that the distances of the several planets from the sun should, at the date thus obtained, be nearly the same.

The orbits of all the planets being movable, it would be preferable to refer the intersections of the orbits in question to a fixed plane suitably situated, and compute the motion of the points of intersection in that plane. For the suggestion of this modification I am indebted to Prof. Peirce, of Harvard University, to whom, in conversation, I communicated the plan here described.

In the close approach of the nodes, the confirmation of the hypothesis in question does not require that all the nodes thus brought into the neighborhood of each other, should be of the same description; viz., all ascending, or else, all descending nodes. On the contrary the confirmation would be the greater, if the result should be different. That such would prove to be the fact, if the approximation were found to have occurred at all, seems to be foreshadowed by the present position (on the ecliptic) of the descending node of Iris, in the region of the ascending nodes of the others.

As before remarked, the period of nearest approach in question will furnish the latest date which we can fix upon for the rupture of the original planet. For it is quite evident that several revolutions of the nodes may have occurred since that event, if it really happened. The approach to an equality of distances, as indicated at the same time, by the requisite changes in the positions of the major axes of the orbits, would in any case, indicate the date, with great probability.

Should the whole investigation indicate no tendency to such an approach of the nodes as has been described, we should have reason to conclude, that the hypothesis of a common origin of the planets in question, in the way supposed, is untrue.

3. *New Comet.*—On Wednesday evening, April 11, 1849, a telescopic comet was discovered near the *Northern Crown*, by Mr. Geo. P. Bond, at the Cambridge (Mass.) Observatory; this being the eighth comet discovered by him before any information thereof had reached this country.

The following places (referred to the mean Equinox of Jan. 1, 1849) were obtained at the Cambridge Observatory.

	Camb. m. t.	A. R.	Decl. N.
1849, Apr. 11,	$10^h\ 56^m\ 29^s$	$15^h\ 9^m\ 6^s{\cdot}11$	28 38 27·
12,	7 57 58	15 3 36 ·28	28 20 9·1
14,	10 35 59	14 48 12 ·14	27 36 33·7
17,	8 48 52	14 20 49 ·60	25 54 23·4

It has a strong, star-like central condensation, an extensive coma and no tail, and was seen on the evening of April 17 by the naked eye.

V. Miscellaneous Intelligence.

1. *On Meteoric Iron in South Carolina;* by Charles Upham Shepard. (Communicated for this Journal.)—For my first knowledge of this meteorite, I am indebted to a letter from Dr. E. H. Andrews, of N. C., dated Concord, January 16th, 1849, in which he observes that he had just been handed two or three pounds of iron, said to have been detached from a larger mass, ploughed up in a field. At my request, Dr. Andrews proceeded to the place, with a view to ascertain the facts in the case. His letter of February 3d, from Chesterville, Chester District, South Carolina, is as follows: "I received yours of the 30th ult., and the next morning came down to this place, in search of the meteoric mass and the facts relating to it, which I find to be these. It was found several years since by a laborer, on the plantation of Mr. Samuel M. McKeown, which is situated about six and a half miles below this place, on the Columbia road. His first impression on ploughing it up, was, that it was the common mountain ore of the region; but observing that it was exceedingly heavy for its size, he took it to the house, where, however, it excited no particular attention, and was accordingly suffered to remain behind an out-building until very recently, when the finder had the curiosity to take it to the blacksmith, who at once proved it to be malleable. He cut several pieces from the mass, out of which he made horse-shoes, nails and hinges for a gate. The original weight of the mass was thirty-six pounds. It has been reduced about one half, and the unworked portion is now in the possession of Dr. Wm. D. Kersh, of Fairfield District.

Its original shape is described as having been oblong, with one side and end thicker and rounder than their opposites; or as possessing the form of a common fresh water muscle (a species of Unio). Its surface was much indented and coated by rust.

I have since received specimens of the mass (two of which were in a wrought condition) obtained by Dr. A., together with the larger piece

also referred to, as being in the possession of Dr. Kersh, abstracts of whose correspondence, as well as a letter from Mr. McKeown, will be presented hereafter in my description of this iron.

I have already ascertained that it contains about 5 p. c. of nickel, besides traces of chromium, cobalt, and nodular masses of magnetic pyrites, which latter substance, when dissolved, exhibits fine, but very brilliant scales of plumbago.

Its most remarkable peculiarity consists in the appearance of its polished surfaces when treated with dilute nitric acid. In one spot, it then shows scattered, but distinct characters, resembling Chinese letters; in another at wide intervals, a series of short, straight lines, with square ends, precisely like dashes in printing; again the brilliant markings are arranged across an uniform ground, so as to simulate the course of a river on a map, or the meshes of a cobweb. The spaces between the raised lines above described are filled up with shining points and fine Widmanstättian figures, presenting on the whole, a surface strikingly similar to that produced in silver when cooled from fusion. It is very dense, and takes a brilliant polish; but its etched surface immediately distinguishes it from every other iron hitherto described.

2. *Staite's Electric Light.*—We have just received in the Mechanics Magazine, the specification in full of Mr. Staite's patented improvements in the production of galvanic light for illumination.

The question of the economical and successful application of galvanic light to the purposes of general illumination, has of late excited considerable interest, and some brief notices of Mr. Staite's labors on this subject have already appeared in the public prints.

One of the principal difficulties in the way, has been the inconstancy of the light of the carbon points or electrodes used, in consequence of the variations in the strength of the current. This difficulty Mr. Staite has endeavored to overcome, how successfully remains to be seen, by means of mechanism for regulating the interval between the carbon points. This he has done in various ways, one of which, we believe, was specified in a former patent granted in July, 1837. One of the simplest specified in the present patent, and that by which we can best illustrate the operation of the others, consists in connecting the lower or negative carbon point or electrode with an iron rod or bar moving vertically in a coil of wire, through which the galvanic current is made to circulate. The iron rod rises by a counterpoise till it brings the carbon point connected with it, into contact with a fixed carbon point above, when the current instantly passes and the coil acts on the iron rod and draws it down and thus separates the two points, and continues to separate them until the current is reduced to a standard quantity, determined by the weight of the counterpoise. If the current begins to fail, the diminished action of the coil allows the counterpoise to bring the points nearer together; if the points approach too near, the current becoming stronger immediately separates them again. To prevent injurious vibrations or sudden movements of the iron rod, it is furnished with a rack, wheel work and fly.

Another improvement consists in giving the upper electrode the form of a circular disc, made to revolve slowly in contact with a fixed scraper which keeps the edge of the disc clean and free from the particles of carbon projected upon it from the lower electrode.

A further and important feature in this patent is the mode specified of preparing the carbon for electrodes, which consists in general in forming powder of charcoal or other suitable form of carbon into a paste, with melted brown sugar, pressing it into iron moulds and baking it in the moulds at a red heat, and afterwards in a crucible at a white heat.

For the form of light in which an ignited platinum wire or foil has hitherto been used, Mr. Staite claims introducing the use of iridium as the hardest and most refractory of the metals; but we doubt whether light produced by the ignition of metallic conductors can be economically used.

We have not room for a description in the present number of the construction of the batteries used and the materials employed in working them. The objects aimed at are economy, convenience, constancy of action, and complete consumption of material.

Whether Mr. Staite's labors have been entirely successful or not, we cannot believe the brilliant light of the galvanic arc is to be forever confined to the laboratory and lecture room of the chemist. If the difficulties hitherto incident to its use can be overcome, and we see no reason why they may not be, there can be little doubt that this may be made the most economical as it is the most powerful source of artificial light known to us.

3. *The Anniversary of the Geological Society for* 1849, *held in London.*—Among the distinguished persons present were the Archbishop of Canterbury, Sir Robert Peel, the Belgian Ambassador, Sir R. I. Murchison, Sir H. De la Beche, Dr. Buckland, Dean of Westminster, and most of the great men of the metropolis. Sir Charles Lyell, the new president, took the chair.

The Archbishop made an admirable speech in defense of scientific pursuits, and of geological researches in particular, and Sir Robert Peel ably sustained similar views,—followed by Dr. Buckland; and Prof. Sedgwick poured forth a flood of unrivalled eloquence. The Belgian Ambassador in capital English, with just sufficient foreign accent to add to its interest, gave a luminous address in praise of science, and a just encomium on his own country, for having remained unmoved in the midst of the revolutionary debacle which has swept over the continent.

Sir R. I. Murchison made a courtly speech complimentary to the nobles present. Sir C. Lyell spoke with his usual good sense, and Dr. Mantell as one of the Vice-presidents made a responsive address. Sir H. De la Beche, has been a capital president, and his address was excellent. The Wollaston medal was awarded to Mr. Prestwick, for his various papers on the tertiary strata of the London and Hampshire basin.

Obituary.

4. Edward Forster, Esq., Vice President of the Linnæan Society, in the 84th year of his age.

5. M. Hommaire de Hell.—This French naturalist died at Ispahan, while on a scientific mission in Persia, under the direction of the French government. M. de Hell was scarcely thirty-four years of age.

6. Dr. George Fownes.—Dr. Fownes, Professor of Practical Chemistry, at University College, London, has recently died at the age of 34. He is the author of an excellent Manual of Chemistry, which has been reprinted in this country.

7. Dr. Prichard, (Ath., No. 1108, p. 70.)—Ethnological science has recently sustained a serious loss by the death of Dr. Prichard. He was well known by his great work "Researches into the Physical History of Man," in five volumes,—and his yet more popular "Natural History of Man." In addition to these, he was the author of "An Essay on the Vital Principle," a treatise on "Insanity," a book "On the Eastern Origin of the Celtic Language," and many other works and essays which appeared in the medical journals. At the time of his death, Dr. Prichard was president of the Ethnological Society.

VI. Bibliography.

1. *Botanical Collections in New Mexico, and in the Rocky Mountains.*—The first part of the Account of the Collection of Plants made in New Mexico by Mr. Fendler, with descriptions of the new species, critical remarks, and characters of other undescribed or little known plants from surrounding regions, is printed as the first article of the fourth volume (new series) of the Memoirs of the American Academy, now in press; and separate copies (of one hundred and sixteen pages, quarto) are distributed to the subscribers to Fendler's collections. We wish to solicit further encouragement to this adventurous explorer, in the way of subscriptions to his collections. Several sets of the Santa Fe collection, in specimens of unrivaled beauty and completeness, are still in the hands of Dr. Gray, at Cambridge, and of Mr. Heward at London, who may be applied to for them. Mr. Fendler is now on his way to explore the great interior basin between the Sierra Nevada of California, and the Rocky Mountains, especially around the Great Salt Lake, the Utah Lake, and the adjacent mountains. The collections are to be studied and distributed by Dr. Gray and by Dr. Engelmann, to whom those desirous to subscribe for them should apply, and will be issued at the same price as the Santa Fe collection, namely at ten dollars per hundred specimens.

In order that the botany of New Mexico should be further made known, particularly of the southern portion, Mr. Charles Wright is now on his way from Texas across to El Paso on the Rio del Norte, a little below lat. 32°, in the vicinity of which, and especially in the mountains east and west of the valley, he will collect during the present season; and the following year he proposes to extend his explorations, as opportunities offer, into other parts of the country, yet untrodden by botanists. Sets of the plants he may collect will be offered to subscribers, in the order of their application, at the same price as those of Fendler.

A. Gr.

2. *Hooker's London Journal of Botany and Kew Garden Miscellany.*—This is the title of a new series of Hooker's Journal of Botany which commenced at the beginning of the present year. It appears that there were not subscribers enough to sustain a single Botanical Journal of the kind; and the attempt is now made to secure an ade-

quate support by reducing the amount of the text and plates and lowering the price. The monthly numbers of the new series therefore consist of thirty-two pages and one plate each, instead of fifty-four pages and two plates, and the price is reduced to *one shilling* per number. Not only are the labors of the editor and the drawings furnished gratuitously to the publishers, but, if we are rightly informed, the editor pays for his own copy besides! It will indeed be a national shame if this excellent journal is not properly sustained at this cheap-literature price, after such sacrifices have been made in its behalf. There ought to be many subscribers in this country, especially since under the new postal arrangement, copies may be sent by mail direct from London to any part of the United States at a moderate rate of postage. The publishers are Reeve, Benham & Reeve, now the most active scientific publishers in Great Britain, and who have for the past two years published the London Journal of Botany, of which this is a continuation of equal interest and importance. The contents of the numbers for January, February, and March are as follows:—

Contents of No. 1.—Dr. Hooker's Botanical Mission to India (*with a plate*)—Dr. Broomfield's Notes on the Botany of the United States—Mr. Spruce's Voyage to the Amazon River—A new Esculent Nut—Patchouly plant—Jute Fibre—Chinese Grass Cloth—Pooah fibre of Nepal—Oadal fibre—Fibre of *Sterculia guttata*—*Musa textilis* or Manilla hemp—Dr. Hooker's Rhododendrons of the Sikkim Himalaya—Walper's Annals of Systematic Botany—Weddell on the genus *Cinchona*—Hertfordshire Flora—Moore's British Ferns—Port Natal Herbarium.

Contents of No. 2.—Professor Henslow on the Awns of Nepaul Barley (*with a plate*)—Dr. Hooker's Botanical Mission to India—Major Madden, on the Botany, &c., of the Turace and outer Mountains of Kumaoon—M. Bourgeaud's intended Botanical excursion in Spain—Fendler's collection of Plants of New Mexico—The late Dr. Taylor's Herbarium—Prof. Lehmann's critical revision of the genus *Potentilla*, and the Flora of South Africa—Botanical Appendix to Captain Sturt's Expedition into Central Australia.

Contents of No. 3.—On the genus *Triguera* of Cavanilles; by John Miers, Esq., F.R.S., F.L.S.—Dr. Thomson's Scientific Mission to Thibet—Dr. Hooker's Botanical Mission to India—Proceedings of the Linnæan Society—Proceedings of the Botanical Society—Mr. I. T. Mackay—Notes on the Botany of California—Deodar Cedar.

The article on the Botany of California consists of a notice of Major Emory's Report of the military expedition from Santa Fe to California by the Gila. The writer concludes that the great tree Cactus which makes such a striking appearance, as figured by Major Emory, and which is described by Dr. Engelmann under the name of *Cereus giganteus*, is no other than the well known *Cereus senilis*, or Old-man Cactus of the conservatories.

The notice of the *Deodar* contains an extract of a letter from Dr. Thomson, written from Kashmir; from which, and from other data, the editor "inclines to the opinion that, if the *Deodar* of the Himalaya had been discovered in a locality nearer to that of the *Cedar of Lebanon*, botanists would have considered it only as a variety of that classical tree; and, tracing it, as we can do according to the testimony of

travellers, from Mount Atlas in the west to the chain of Taurus and Altai in the east, we may fairly infer that the same species reaches the Himalaya range, and stretches as far as Kamaon. A. Gr.

3. *Posthumous Papers, bequeathed to the Hon. East India Company by the late* Wm. Griffith, F.L.S., &c., and printed by order of the government of Bengal.—To botanists there is no need of speaking of the loss which science has sustained in the death of Wm. Griffith in early manhood, in the midst of a career, which, with his excellent opportunities, improved to the utmost by his extraordinary talents and industry, was confidently expected to furnish the most important contributions of the age to the advancement of vegetable anatomy and morphology. Had he even survived to prepare for the press the notes and drawings which embody the results of the researches he had already made, these would have had a great influence upon the science. These unfinished materials, with his collections, were bequeathed to the East India Company; the directors of which have caused them to be printed, and a portion of the edition to be distributed among the botanists who are likely to be most benefited by them. The printing is now going on, at Calcutta, under the editorial direction of Dr. John McClelland.

The portion which we have received was printed in 1847, and consists of, 1st. *Journals of Travels in Assam, Burma, Bootan, Affghanistan, and the neighboring countries*; in an 8vo volume of 529 pages, with numerous sketches on stone and a lithographed portrait of Mr. Griffith. 2d. *Notulæ ad Plantas Asiaticas*: Part I. *Development of Organs in Phanerogamous Plants*, pp. 255, 8vo; with an Atlas of 62 large quarto plates, filled with microscopic details, of the highest interest. A. Gr.

4. *Bibliographia Zoologiæ et Geologiæ, &c.*; by Prof. L. Agassiz. Corrected, enlarged and edited by H. E. Strickland. Vol. 1, 1848, pp. 506. Containing the Periodicals, and Alphabetical list of authors for *A.* and *B.* Published by the Ray Society.—This work, the result of many years laborious research, is in course of publication, under the auspices of the Ray Society. The former edition in large folio was printed only for private distribution. The *first part* of the volume just issued, extending to 85 pages exclusive of the preface, is devoted to a list of periodicals and cyclopedias, of which nearly 500 are catalogued, with the date, place of publication, and number of volumes. Under Africa two are cited; Asia 14; Australia 2; New York 12; Philadelphia 13; London 82; Madrid 4; Lisbon 3; Venice 14; Turin 24; Pisa 8; Naples 15; Padua 11; Milan 26; Lausanne 9; Geneva 8; Berne 15; Paris 84; Lyons 12; Caen 10; Brussels 16; Prague 11; Nürnberg 19; Leipzig 45; Halle 15; Berlin 50; Amsterdam 18; St. Petersburg 19; Moscow 9; Copenhagen 26. This will afford an idea of the fullness of this portion of the work.

The *second part* commences with the name of Aalborg, who published two works on bees at Copenhagen in 1639–42. Agassiz himself has a list of 81 works or papers, the first of which bears the date of 1828, and some of his latest contributions have not been included. Audouin is cited for 73 works, papers, &c.; Audubon 11; Bachman 6; J. W. Bailey 7; D. W. Barnes 3; H. Barnes 4; B. S. Barton 17;

Bartram 8; Elie de Beaumont 40; Th. Bell 31; E. T. Bennett 60; Berthold 32; G. Bischoff 19; T. L. W. Bischoff 24; Blainville 150; Blumenbach 41; Boie 39; Bonaparte 49; Boué 67; Brandt 65; Brehm 43; Brocchi 30; Ad. Brongniart 20; Alex. Brongniart 50; Bronn 38; Buch 78: Buckland 61, &c.

A work of this kind must contain examples of various languages (the titles being generally given in the original), and the editor has succeeded in giving the text with remarkable accuracy. In the extensive list of Blainville, No. 127, is a repetition of No. 6. A curious error appears under the name of *W. E. Buch*, which should be *Leach;* this error has doubtless arisen from writing or copying the name from German manuscript, in which one of these names might be readily mistaken for the other.

This work will exercise a wholesome influence upon science, as it will lead authors to a knowledge of the great amount of materials which has accumulated during several centuries. S. S. H.

5. *Observations at the Magnetic and Meteorological Observatory, at the Girard College, Philadelphia, made under the direction of* A. D. Bache, LL.D., *and with funds supplied by the members of the American Philosophical Society, and by the Topographical Bureau of the United States,* 1840 *to* 1845. *Printed by order of the Senate of the U. S., and under the direction of the Topographical Bureau.* Washington, 1847, (issued in 1849,) 8vo, pp. xlix, and 3212, bound in 3 volumes, with Atlas of 210 plates.

The observations recorded and digested in these volumes, were undertaken in compliance with the plan proposed by the British Association for the Advancement of Science. "A great union was thus formed, which finally embraced more than thirty observatories, in the four quarters of the globe, carrying on simultaneous observations upon the same plan and with similar instruments."

It is gratifying that our country has made so valuable a contribution to the progress of this great work, and that the government has with an enlightened liberality assumed the expense of communicating to the scientific world, in a convenient and accessible form, this important mass of materials.

The volumes are introduced by a preface from Dr. Bache, in which he gives a description of the Observatory, the names of the observers and computers, the instruments employed, the modes of observation, and other interesting notices.

We have no room for an extended account of the contents of these volumes, nor is it here necessary, as the work will be sought for and valued by all persons engaged in investigations of the subjects to which they relate. We can not refrain however, from expressing the gratitude of the scientific men of this and other countries to Dr. Bache, and his corps of associates, and also to the Senate of the United States, for this important contribution to the stock of knowledge.

6. *An Introduction to Practical Chemistry including Analysis;* by John E. Bowman, Demonstrator of Chemistry in King's College, London. Philad.: Lea & Blanchard. 1849. 12mo, pp. 303. With numerous wood cuts.—This work is designed for beginners in chemistry, and is a well arranged guide to the common processes of the labora-

tory, including the preparation of the most frequently used reagents. The construction and use of apparatus is also explained, and the manipulations in glass-blowing rendered simple by good cuts.

The action of the most frequently occurring bases and acids with reagents, is also treated of much after the manner of Fresenius, as well also as the outline of qualitative and quantitative analysis. An Appendix contains various useful tables of weights, measures, &c., as also of strength of acids, alkalies, the thermometer, degrees of solubility, &c., to which is added a glossary of terms.

American students are much indebted to Messrs. Lea & Blanchard for the promptness with which nearly every useful work of the English press, on chemistry and other kindred sciences, is reproduced by them.

7. *Gmelin's Chemistry.*—(Hand-Book of Chemistry, by LEOPOLD GMELIN, Professor of Chemistry in the Univ. of Heidelberg, &c., &c. Vol. I. Cohesion—Adhesion—Affinity—Light—Heat and Electricity. Translated by HENRY WATTS, B.A., F.C.S. London: printed for the Cavendish Society, 1848.)—This truly important addition to the chemical literature of the English language, is presented to chemists as one of the offerings of the Cavendish Society, lately formed in London, on a plan similar to that of the Ray Society, and which promises to do for chemical science what the latter has already begun to do so well for natural history. Gmelin's Hand-Book is a work of great erudition, being little else than a complete exposition of all the researches which have thus far unfolded any important truths in chemical science. The first volume now before us (of 519 pages, and 4 copper plates), is exclusively devoted to the physics of chemistry, and will be a rich mine of accurate facts and full references, for many readers, to whom the original German has been a sealed or an inaccessible book. We have been astonished in a rapid review of this volume —at the amount and variety of laborious research and precise statement exhibited in every page which we have read. It is a guide for the teacher and still more for the investigator, rather than a text-book for the student—and as such, will not fail to find its place on the table of all who strive to keep up with the rapid progress of this active day, in which chemistry is advancing with a rapidity known in few other sciences at any period, and unsurpassed by none at present. Did our space permit, we should be glad to transfer to our pages a full conspectus of this valuable volume. Two of the remaining volumes of this system are promised by the Council of the Cavendish Society during this year, if a sufficient addition is made to the number of members.

8. *Transactions of the American Ethnological Society*, vol. ii, pp. 637, 8vo. *New York.*

I. Hon. ALBERT GALLATIN: The Indians of North West America.

II. E. G. SQUIER: Observations on the Aboriginal Monuments of the Mississippi Valley.

III. Prof. C. C. RAFN of Copenhagen: View of the Ancient Geography of the Arctic Regions of America, from Accounts contained in Old Icelandic MSS.

IV. S. G. MORTON: Account of a Craniological collection, with remarks on the Classification of some Families of the Human Race.

V. T. DWIGHT: Sketch of the Polynesian Language, drawn up from Hale's Ethnology and Philology.

VI. A. C. COTHEAL: Grammatical Sketch of the Language spoken by the Indians of the Musquito Shore.

VII. S. WELLS WILLIAMS: Present Position of the Chinese Empire, in respect to the Extension of Trade and Intercourse with other Nations.

VIII. T. DWIGHT: Sketch of the Mpongwes and their Language, from Information furnished by Rev. John Leighton Wilson, Missionary of the American Board.

Appendix. JOHN R. BARTLETT: Progress of Ethnology.

9. *Verhandlungen der Russisch-Kaiserlichen Mineralogischen* Gesellschaft zu St. Petersburg. Jahr. 1847, St. Petersburg, 1848.

Dr. A. VON VOLBORTH: On a Russian Trilobite, (Zethus verrucosus,) Tab. i, figs. 5, 6, 7.

A. G. KEYSERLING: Remarks on the Relations of the Nummulites in Structure.

M. KOSITZKY: Geological Observations in Northeastern Siberia, made during the years 1844 and 1845.

Prof. L. ZEUSCHNER: Upon a part of the Carpathians.

Dr. C. GREWINGK: Geological account of California.—(From published accounts of the Region.)

B. JEROFEJEW: On the Chalk and Sandstone of the district of Novgorod-Sewersk.—Tab. ii.

N. VON KOKSCHAROW: On a new crystalline form of Scapolite, with wood cuts and Tab. iii. Also, on the Crystallization of Uralorthite: Tab. iv and v.

A. G. SCHRENK: Minerals of Zylyma (in Petschora).

Dr. BRANDT: On the Dodo.

W. VON BECK: Chemical analysis of Glinkite.

S. KUTORGA: On the Sphonotretæ. Tab. vi and vii. (Includes seven species of Siphonotreta; also the new genera *Schizotreta*, in which the aperture is on the opposite side of the beak from what it is in Siphonotreta, *Acrotreta*, having a high 3-sided pyramidal form and aperture at summit inclining the same way as in Schizotreta; and *Aulonotreta*, corresponding to *Obolus* of Eichwald, and *Ungula* of Pander.)

S. KUTORGA: On the Baltic Silurian Trilobites, Tab. viii.

W. THOMPSON, Esq., Pres. Nat. Hist. and Phil. Soc., Belfast: The Natural History of Ireland. 434 pp. 8vo, vol. I. *Birds: London*, 1849. 16*s*.

ROBERT HUNT: The Poetry of Science. 8vo, 487 pp. *London*, 1849, 12*s*.

SIR W. JARDINE: Contributions to Ornithology for 1848. Three parts, 3*s*. each.

SIR EDWARD BELCHER: Narrative of the Voyage of H. M. S. Samarang in the Eastern Archipelago from Borneo to Korea and Japan. 2 vols., 8vo, 960 pp. 35 charts, plates and etchings. *London*. 36*s*.

GEORGE GARDNER: Travels in the Interior of Brazil during the years 1836–1841. 1 thick vol., 8vo. *London*. 18*s*.

Dr. HARVEY: History of British Seaweeds. Part 39. Six colored plates. 2*s*. 6*d*.: large paper 5*s*. *London*.

LOVELL REEVE: Conchologica Iconica—Demy 4to. Part 72. Eight colored plates: 10*s*. Uncolored Issue, Part 12, six plates, 2*s*. 6*d*. *London*.

Mrs. Hussey: Illustrations of British Mycology, with colored drawings. Part 24. Royal 4to. *London.* 5*s.*

J. D. Hooker: Rhododendrons of the Sikkim-Himalaya. Imp. folio; with ten colored plates. *London.*

Dugald Campbell: Practical Text-Book of Inorganic Chemistry, with Qualitative and Quantitative Analysis. *London*, 1849.

J. J. R. Jackson: Minerals and their uses, in a series of Letters to a Lady. *London*, 1849.

Charles Wilkes, U. S. N., Commander U. S. Expl. Exped. 1838–1842: Western America, including California and Oregon, with maps of the region and of the Sacramento Valley.

E. Forbes: Monograph of the British naked-eye Medusæ. 104 pp., with 13 colored lithograph plates. *London.* 1848.

Alder & Hancock: Monograph of British Nudibranchiate Mollusca. 12 pl. *London.* 1848.

The Western Boatman: a monthly periodical, published at Cincinnati, devoted to navigation, and containing a steamboat directory, and a registry of pilots and engineers; by D. Embree. March, 1849, Vol. I, No. 9. This number contains a valuable article on steam and steam explo-ions, by the editor.

Report of Prof. Alexander D. Bache, Superintendent of Weights and Measures, for 1846–1847. Executive Document, No. 73, Senate, 30th Congress, 1st session. Ordered to be printed, Aug. 12, 1848.

W. E. Logan: Geological Survey of Canada: Report on the north shore of Lake Huron. 47 pp., 8vo, with two maps. *Montreal*, 1849. Mr. Logan in his valuable report states that there are twenty-two mining stations on the north shore of Lake Huron, recognized and claimed by the English, the principal of which, Bruce's Mines, are situated under the meridian of 84°.

Determination of the Latitude with Zenith and Equal Altitude Telescope.—Published under the direction of the Topographical Bureau of the War Department. Paper No. 2. *Washington*, 1849.

Proceedings of the American Academy of Arts and Sciences at Boston, Jan. 1849.—A discussion of the observations on the planet Metis, with a determination of its orbit, accompanied by a computation of the subsequent perturbations of the orbit and an ephemeris; *B. A. Gould, Jr.*

Proceedings of the Acad. Nat. Sci. of Philadelphia, vol. iv.—AUGUST, 1848, p. 75. On four skulls of Shoshonee Indians; *S. G. Morton.*—p. 77. Description of a new Mexican quail (Ortyx thoracicus); *Wm. Gambell, M.D.*—Dipodomys agilis and Muscalifornicus, two new Californian Quadrupeds; *Wm. Gambell.*—OCTOBER. p. 85. A new Tanagra (T. nigro-aurita) from Rio Negro, S. A.; *J. Cassin.*—p. 86. Notes of the post-mortem appearances observed in a Cynocephalus porcarius; *E. Hallowell.*—p. 87. Catalogue of birds collected between Vera Cruz and City of Mexico; *Wm. H. Pease.*—p. 81. On the Geology and Natural History of Mexico; *Wm. H. Pease.*—p. 95. Catalogue of the tertiary testacea of the United States; *H. C. Lea.*—DECEMBER. p. 116. On the development of the Purkinjean corpuscle in bone; *J. Leidy.*—p. 117. On the intimate structure of articular cartilage; *J. Leidy.*—p. 119. On the arrangement of the areolar sheath of muscular fasciculi and its relation to the tendon; *J. Leidy.*—p. 121. Descriptions of two new genera (Parapholas and Cryptomya) and new species of recent shells, &c.; *T. A. Conrad.*—p. 121. Descriptions of four new owls (Ephialtes sagittatus, E. Watsonii, Syrnium albo-gularis, and S. virgatum), the last three from South America; *J. Cassin.*—p. 126. Salamandra lugularis, a new species; *E. Hallowell.*—Contributions to American Ornithology. (including two new species of Sterna); *W. Gambel.*—p. 130. Report of Librarian.—p. 132. Report of the Curators.—JANUARY. p. 145. On the existence of the intermaxillary bone in the embryo of the human subject; *J. Leidy.*—FEBRUARY. p. 151. Notes of the post-mortem examination of a Cynocephalus; *E. Hallowell.*—p. 152. New fresh water and marine shells, (Unio 9 species, Margaritana 1, Melania 5, Solecardia (new gen.) 1, Petricola 1, Cyathodonta (new gen.) 1, Pholadopsis (new gen.) 1, Parapholas 1, Penitella 1, Tritor 1, Oliva 1); *T. A. Conrad.*—p. 157. New species of Nyctate and Syncobius; *J. Cassin.*—p. 158. Notes on the Vulturidæ and Strigidæ in the collection of the Academy; *J. Cassin.*—Catalogue of the Vulturidæ in the collection of the Academy; *J. Cassin.*

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